POWER PLANT ENGINEERING

Trade Mark, Reg. U. S. Pat. Office

VOL. XXVII CHICAGO, JANUARY 15, 1923 No. 2

New Plant at the Bayway Refinery

CENTRALIZED CONTROL AND COMBINATION COAL AND GAS FIRED BOILERS ARE FEATURES OF PARTICULAR INTEREST

RUNNING DOWN to Perth Amboy from New York City on the Central Railroad of New Jersey, the traveler cannot fail to be impressed just after passing through Elizabeth, by a vast aggregation of tanks, stacks, overhead pipe lines, etc., which experience will tell him is an oil refinery. This plant which is known as the Bayway Refinery of the Standard Oil Company, numbers among the largest in the world and covers a ground area of over 1000 acres. Situated as it is within 10 mi. of the Atlantic Ocean, it is difficult for the layman to grasp the fact that this plant is connected directly to the mid-continent oil fields in Oklahoma and Texas by underground pipe lines; yet this is how much of the oil is supplied.

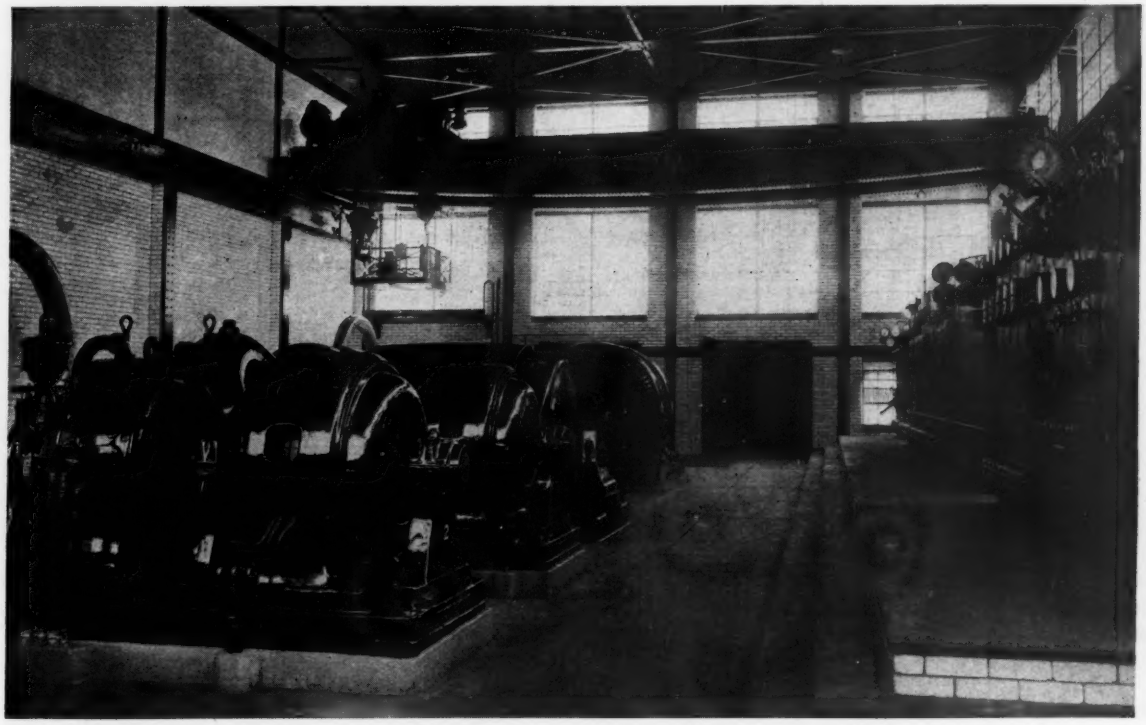


FIG. 1. THE TURBINE ROOM POSSESSES AN ATMOSPHERE OF CLEANLINESS

While it may be true that the process of refining petroleum lacks the romance and thrills that go with the finding of this valuable mineral product, it is nevertheless one of the most important of our industries. In its crude state petroleum can be used only as a fuel, and then with few exceptions it is dangerous because of its gasoline content. When petroleum is refined, not only are the valuable products such as gasoline and kerosene extracted, but at the same time there is produced a refined fuel which can be handled with perfect safety; the more complete the refining process, the more numerous the products which can be separated from the crude oil.

Although impressive in external aspect because of its vastness, a layman's visit to a large refinery is perhaps disappointing. All he sees are tanks, pipe lines, and the outside brickwork of the stills. Little excitement awaits him and no sound is heard save the hum of motors and the rhythmic clanking of pumps. Everything seems to

go on automatically; and this is true—everything does go on automatically, but in order that it may do so a large amount of power must be supplied. Besides the stills, tanks, agitators, storing and loading facilities, it is necessary to have boiler houses, pump houses and power plants. The power plants constitute an important item in oil refining, in fact an indispensable one.

At the Bayway Refinery there has been erected within the last 18 mo., a new power plant as complete in mechanical equipment and as efficient in operation as any plant of its kind in the country. There are other power plants at this refinery and the new one supplies only a part of the total amount of power used. A particular feature of this new plant is that it operates partly upon by-product fuel from the refining processes.

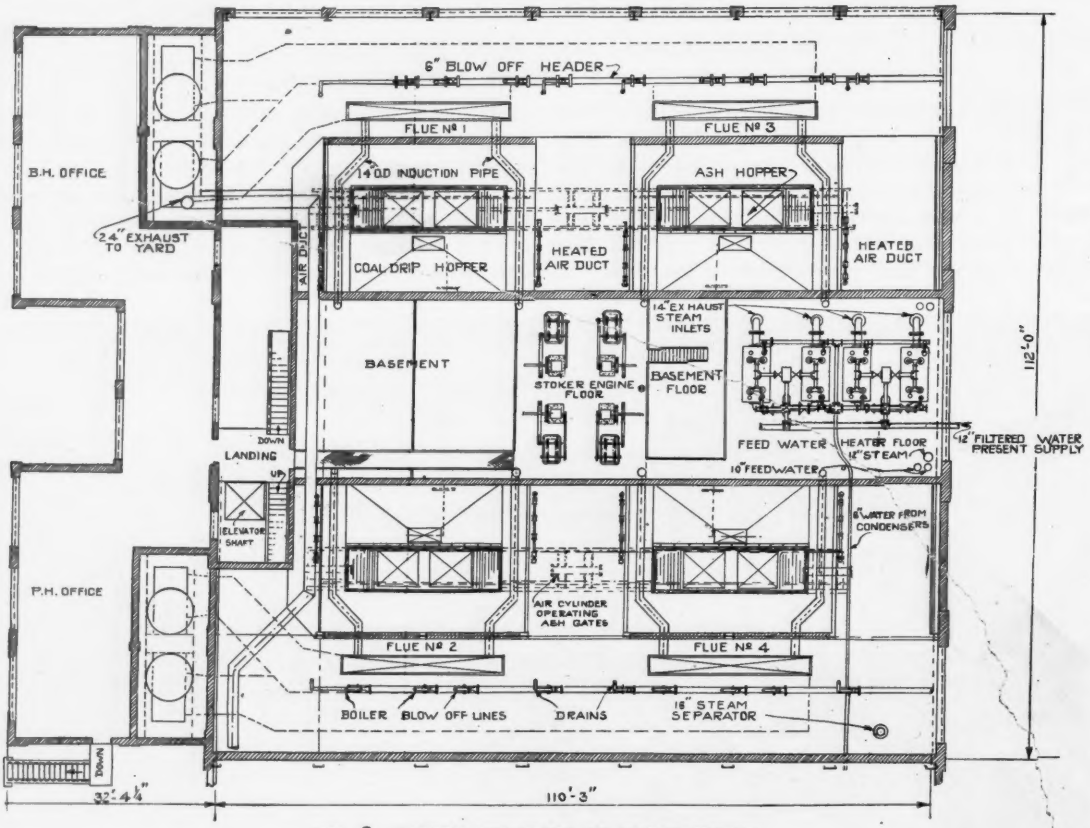


FIG. 2. MEZZANINE FLOOR OF BOILER HOUSE

General Features

An exterior view of the new power plant is shown in Fig. 10. It is of steel and concrete construction and as may be noted, the entire building is faced with brick. Large windows set in steel sash are provided on all sides of the building insuring ample natural illumination throughout. The boiler room floor instead of being provided with windows is provided with large openings fitted with steel curtains. In warm weather, these curtains may be thrown open so as to allow air to circulate freely throughout the entire boiler room. These curtains may be seen in Fig. 10.

Four steel stacks are installed, two for each side of the boiler room. These are of relatively low height as power plant stacks go, for two reasons: first, because both forced and induced draft is employed, thus relieving the stacks of producing the draft necessary to insure combustion, and secondly, because of the plant's location in the midst of an oil refinery where conditions permit the products of combustion to be discharged at a lower altitude than would be possible in a residential or business community.

Coal for immediate use is stored in the overhead bunkers in the boiler room to which it is delivered by the crane shown in the photograph.

Steam is distributed from the plant through miles of overhead piping, all of which is effectively lagged with magnesia insulation and water-proof coverings. Ninety-five per cent of all water used in the boilers is make-up, only 5 per cent being returned.

Coal Handling

It would be difficult to find a more elaborate or a more effective coal handling system than that employed at this plant. A good idea of the nature of this system and its size may be obtained by reference to the photograph, Fig. 5. The steel structure upon which the cranes run is approximately 110 ft. in height, and was designed by and constructed under the direction of the engineering department of the company.

Railroad cars running on tracks under both sides of the crane structure deliver coal into a 4000-T. concrete storage pit underneath the crane runway proper. From this bin it is removed by either of two cranes. These are Champion cranes equipped with Westinghouse direct current motors and control equipment, and having a

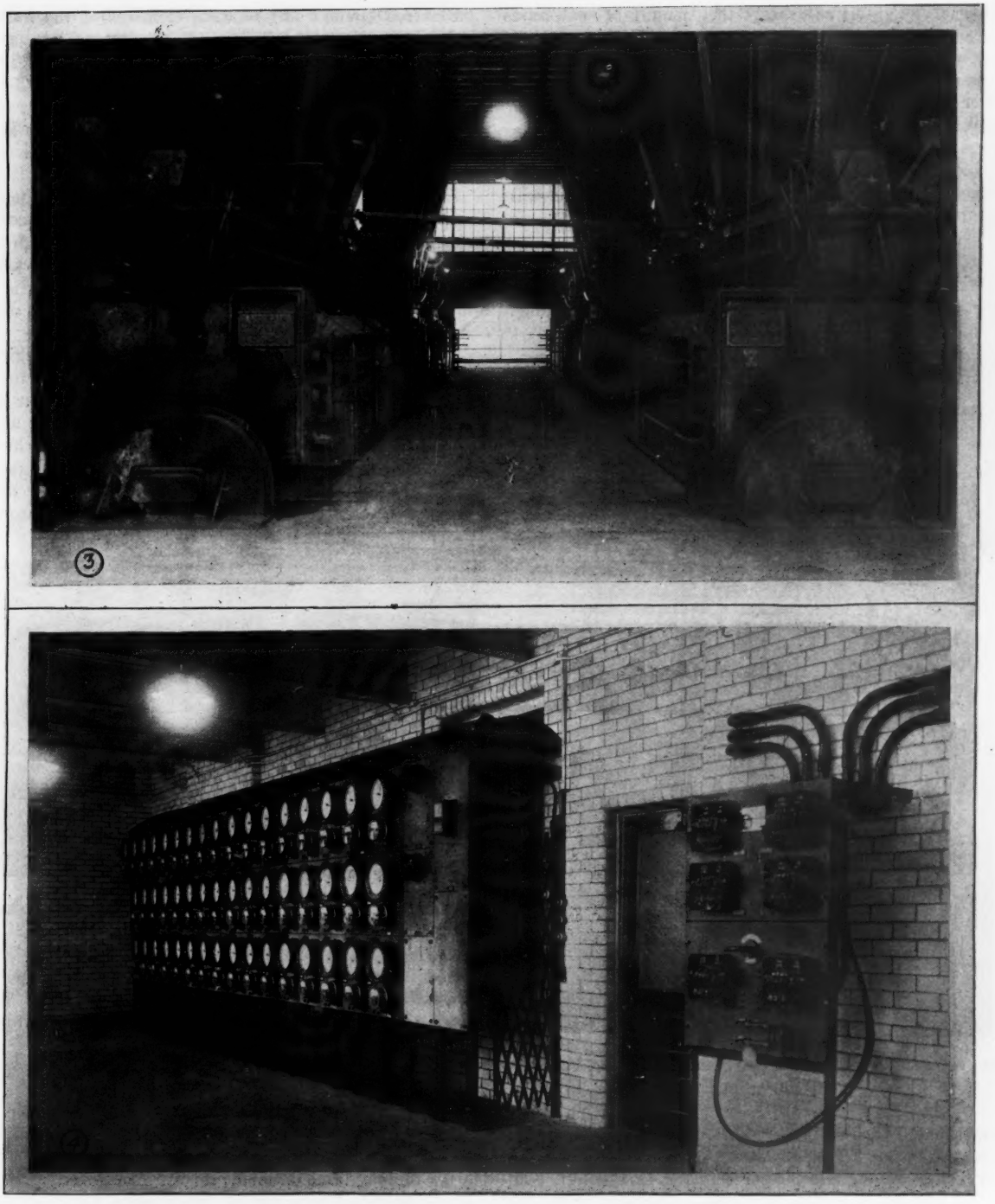


FIG. 3. GOOD ENGINEERING IS REFLECTED IN THE APPEARANCE OF THIS BOILER ROOM
FIG. 4. IN THE METER ROOM, SHOWING THE FLOW METER PANEL AND REMOTE VALVE CONTROL EQMIPMENT

capacity of 12 T. each. The speed of the cranes on the horizontal run is 920 ft. per min. and the speed of the vertical lift is 240 ft. per min. Each crane carries a 5 cu. yd. bucket. The height of the lift is 105 ft. and the total length of track, including the portion within the boiler house, is 500 ft. This equipment when operating has a normal capacity of 150 T. of coal per hr.

In the boiler house, the cranes deliver the coal directly into the over-head bunkers. These are of steel, located over the firing aisle, and are part of the building construction. They are entirely enclosed and separated from the boiler room proper, thus reducing the dust nuisance to a minimum. These bunkers have a capacity of 2500 T.

For delivering the coal to the stoker hoppers, there are installed five chutes to each boiler as may be noted in Figs. 3 and 7. While this arrangement is satisfactory as far as reliability of operation is concerned, it lacks a

means of weighing accurately the amount of coal used by each boiler. It is contemplated, therefore, to install four weigh larries, one for each boiler, which will enable a quantity of coal to be weighed and then delivered to either of the five chutes for each boiler.

While efficiency is of prime importance in the operation of this plant, reliability is perhaps of even greater importance, and to obtain reliability all equipment is of rugged construction. Inspection of the photographs will bear out this statement.

Boiler Equipment

Steam is generated in four Bigelow-Hornsby water tube boilers at a pressure 175 lb. gage, with 100 deg.

FIG. 5. THIS COAL HANDLING EQUIPMENT HAS A CAPACITY OF 150 T. PER HR.

superheat. Each of these boilers is 11 sections wide, and 5 sections deep, giving 13,920 sq. ft. of heating surface in the boiler proper and 30 per cent, or 4176 sq. ft. additional surface in economizer space. The fifth or the last section at the rear of the boiler acts as an economizer, although it is actually a part of the boiler itself. Three and one-quarter-inch tubes are used in the boiler section and 2½-in. tubes in the economizer section. The sections are suspended from the roof girders of the building in the manner shown in Fig. 9.

These boilers are designed for a steam pressure of 180 lb. with 120 deg. of superheat, and are rated at 1392 hp. Foster superheaters are installed between the second and third sections of the boiler. These are entirely suspended from above, giving perfect freedom for expansion.

Eleven Diamond soot blowing elements of the hand revolving type are installed on each boiler. These are operated at regular intervals and keep the tubes free from excessive accumulations of soot and dust. Ten safety valves are installed on each boiler unit, eight on the steam drum and two on the superheater. These are all 4½-in. Consolidated valves and exhaust to the atmosphere through the roof.

Each boiler is provided with three blowoff headers. These are connected to the first, fourth and fifth or economizer sections. Each header is connected through a 2½-in. Homestead blowoff cock and a 2½-in. Hovalco blowoff valve to the main blowoff header. The latter is a 6-in. line installed below the boiler room floor, and discharges into a sump.

Two separate feed lines are installed, either of which can take care of the boilers operating under full load conditions. These lines run horizontally in the rear of the boilers as shown in the accompanying diagrams and at each boiler are joined to a common 4-in. line which feeds each of the 11 economizer units through a 4-in. feed water manifold. The feed lines to each boiler are equipped with Stets, Type B, feed water regulators,

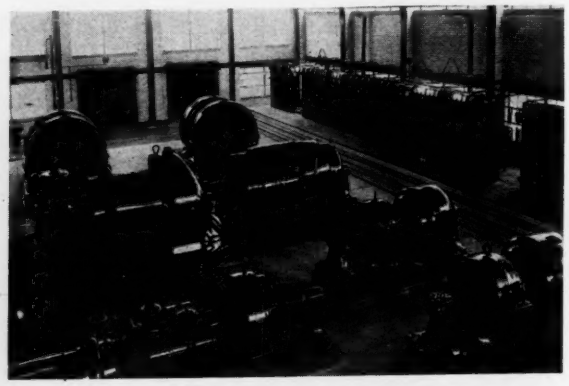


FIG. 6. ANOTHER VIEW OF THE TURBINE ROOM, TAKEN FROM THE CRANE

placed between the feed water manifold and the point of connection to the two main feed water headers. The latter are 8-in. lines tapering to 6 in. and are equipped with 6- and 8-in. gate valves.

Forced Draft

Coal used under these boilers is anthracite, No. 3 and 4 buckwheat. This is burned upon Illinois chain grate stokers, the active surface of which is 24 ft. wide by 17 ft. long, and divided into five draft zones. Each zone is supplied with air by two Coppus Vano blowers. The entire furnace therefore has 10 blowers, eight 20-in. blowers and two 16-in. blowers, these units being steam driven and installed along each side of the furnace.

This method of supplying forced draft at various pressures in different zones is a highly effective method of obtaining economical combustion. The air supplied through each zone is regulated in accordance with the fuel bed resistance at that point. At the forward part of the grate, for instance, where the green coal enters, the fuel bed is thick and a high draft pressure is needed to force the required amount of air through the bed. As the stoker moves toward the rear of the furnace, the fuel

is consumed and the thickness of the fuel bed is reduced. The draft pressure in the zones at this part of the furnace should be lower than that at the forward part of the furnace, otherwise heavy excess air losses would ensue.

These draft zones referred to are nothing more than closed compartments set between the upper and lower elements of the chain grate stokers, with the blowers placed at each end. As a certain amount of ash and coal passing through the grate links tends to accumulate on the bottom of these compartments, ash gates are provided. These gates are operated by levers at the sides of the furnace as may be noted in Fig. 8.

As stated above, the unit blowers are steam driven, supplied from a common header, the steam pressure in which is controlled by a compensating steam regulator. Each blower is further individually controlled by compressed air-operated, quick closing valves, operated in conjunction with the balanced draft system. The balanced draft system is that of the Engineer Co. and controls the forced and induced draft fan turbines and the stoker driving engines.

Furnace walls are made up of 13½-in. firebrick, 4½-in. Insulbrix, 4½-in. nonpareil, 9-in. red brick and 18 in. of carborundum at the sides of the stokers. The stokers are split in the middle so that each side may be driven separately. The driving elements are Westinghouse, two-cylinder steam engines, belted to line shafting through single acting Reeves variable speed transmission units. The stoker drive line shafting and the driving engines are installed below the boiler room floor as may be noted in Fig. 7, the engines being located on the stoker engine floor. There are four stoker driving units, one for each boiler. The stokers are driven from the line shafting through bevel and worm gearing.

Fuel bed thickness is controlled by feed gates operated by 24-in. handwheels through a worm gear, two gates being provided for each boiler. Under normal operating conditions, the thickness of the fuel bed averages about 4 in.

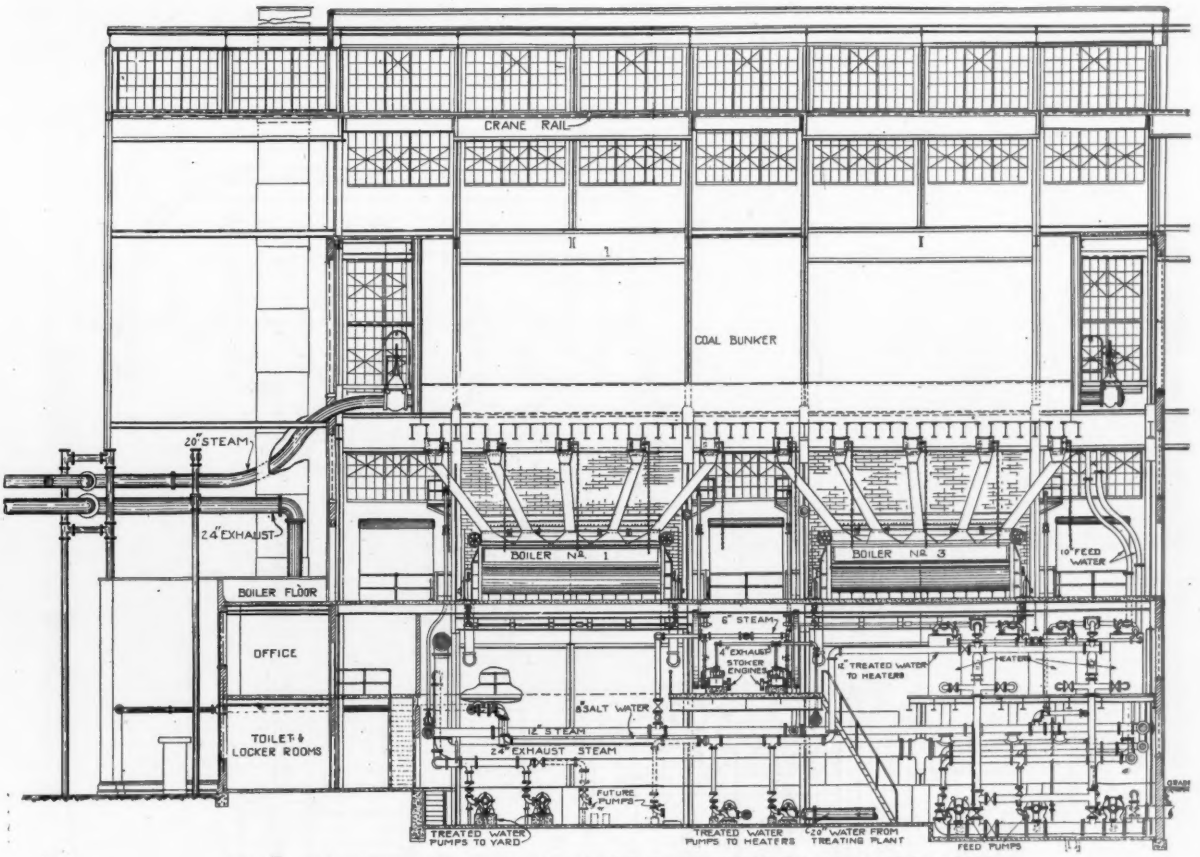


FIG. 7. LONGITUDINAL SECTION THROUGH CENTER AISLE OF THE BOILER ROOM

Firebox temperatures vary from 2400 to 2600 deg. F. and the stack temperatures from 450 to 500 deg. F.

Induced Draft

Flue gases are taken away from the boilers by means of two induced draft fans. These are made by the American Blower Co., driven by General Electric Co. steam turbines through Poole reduction gears, and have a capacity of 180,000 cu. ft. per min. against a pressure of 4½ in. of water.

All gases of combustion are removed from the boilers from below and are conveyed by virtue of the negative pressure due to the exhaust fans, through flues installed in the basement to the fan rooms at the end of the boiler houses. Here the gases are delivered to the stacks, of which there are four, two being provided for each side of the boiler room. The arrangement of the flues is simple as the accompanying drawings will show. A gate is installed in each line of breeching so that any stack may be cut out of service if conditions so demand. The

stacks are of ⅜-in. steel plate, 7 ft. in diameter by 90 ft. in height and are unlined. They are securely anchored to the building.

Air Preheating

A novel feature of this plant is the method of heating the air supplied to the furnaces for combustion. This air is made to pass through the chambers in which the breeching from boilers to stack is installed, and in this manner acquires a high temperature by contact. At the same time, the temperature of the flue gas is reduced somewhat. While the amount of heat reclaimed by this arrangement is small, it is one of those small increments in plant operation which, when taken collectively, make up the difference in operating efficiency between one plant and another. It was not with the primary object of reclaiming heat that the flues were installed in this manner, but since the arrangement adapted itself readily to the reclamation of heat the slight additional expense involved in carrying out the idea is fully justified.

This idea is also carried out in the disposition of the air from the generator windings. This air also is delivered into the air duct supplying the furnaces.

Provision for Burning Gas

In addition to burning coal the boilers at this plant are also equipped for burning gas, a considerable quantity of which is available at the refinery. This gas is burned simultaneously with the coal.

There are two gas burners on each side of the boiler. These are set in two 10-in. sleeves set in the sides of the furnace as shown in Fig. 8 and are installed so that the flame may be directed into any part of the furnace. They are installed at distances of 15 in. and 2 ft. 9 in. above the grate, respectively.

This combination of coal and gas firing has been found highly satisfactory and makes it possible to meet wide variations in load upon short notice. At the time of the writer's visit to the plant, one of the boilers was carrying 3400 hp. burning coal and with only one gas burner in operation. By starting up the remaining three burners the rating could have been increased to a considerable extent in a short space of time.

When burning gas in combination with coal in this manner, only enough coal is used to form a thin layer over the entire grate surface. This layer of fuel protects the grates from the intense heat of the gas flame and also prevents undue radiation losses through the grates.

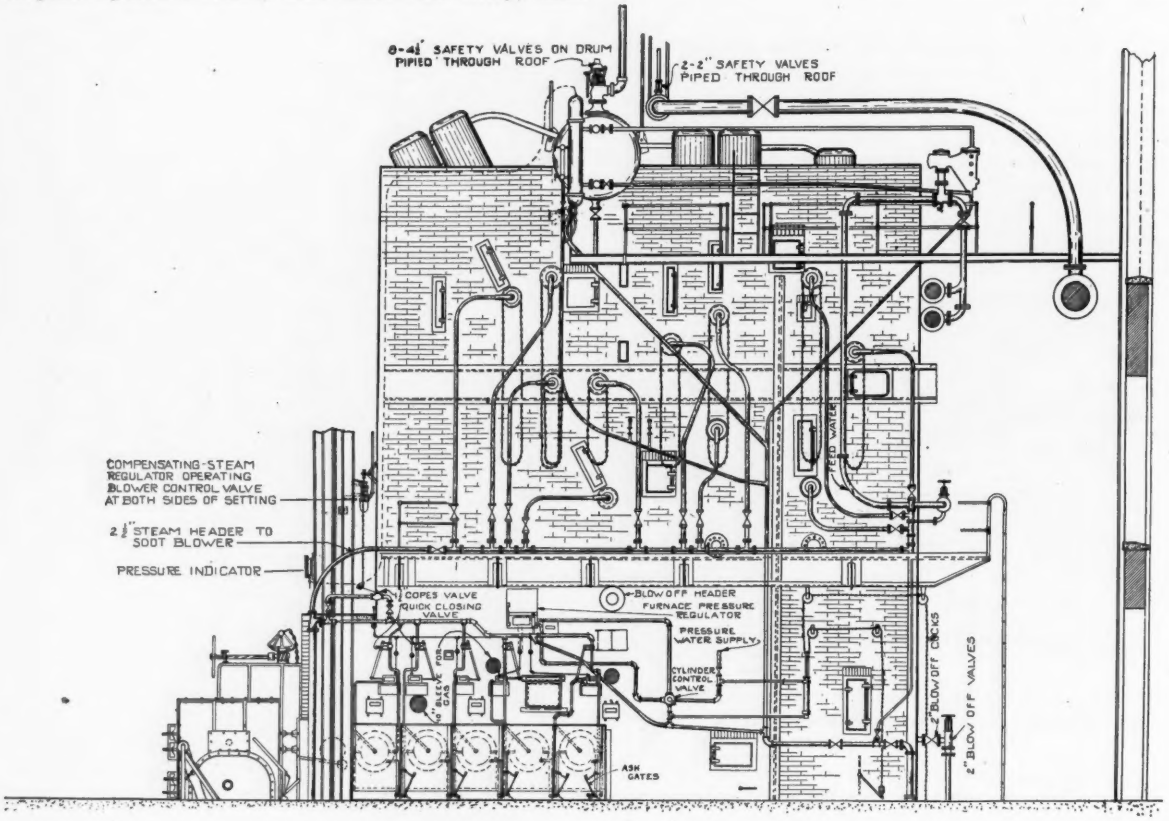

8-4½" SAFETY VALVES ON DRUM PIPED THROUGH ROOF
2-2" SAFETY VALVES PIPED THROUGH ROOF
COMPENSATING-STEAM REGULATOR OPERATING BLOWER CONTROL VALVE AT BOTH SIDES OF SETTING
2½" STEAM HEADER TO SOOT BLOWER
PRESSURE INDICATOR
COPES VALVE QUICK CLOSING VALVE
BLOW OFF HEADER FURNACE PRESSURE REGULATOR
PRESSURE WATER SUPPLY
CYLINDER CONTROL VALVE
GAS
ASH GATES
FEED WATER
2" BLOW OFF CHECKS
2" BLOW OFF VALVES

FIG. 8. SIDE ELEVATION OF ONE OF THE BOILERS

Ash discharged over the rear of the chain grate stokers collects in the ash hopper below the boiler room floor and is discharged therefrom by the opening of compressed air-operated, Baker, Dunbar and Allen ash gates. These hoppers have sufficient capacity to hold the ashes of a 16-hr. run and are equipped with a 3-in. sprinkler line to cool the ash and to keep down the dust. Salt water is used for spraying the ashes, the supply being obtained from a 4-in. salt water header as shown in Fig. 9. Ashes is discharged directly into standard gage railroad cars in the room below the boilers.

Coal drippings from the stoker collect in the coal drippings hopper located adjacent to the ash hopper. The latter are fitted with hand operated gates.

Boiler Instruments

For recording and determining operating performance an excellent collection of recording and indicating instruments is installed. Each boiler has one Republic duplex flow meter; one average thermometer across the economizer with two pen charts, manufactured by the Brown Instrument Co.; one Mono CO_2 recorder; one Bailey 9-point draft meter; one recording steam temperature thermometer; one recording thermometer for feed water temperature from the economizer, both of which are made by the Brown Instrument Co.; and two Ashcroft pressure gages. Republic flow meters are also installed on all of the boiler feed lines.

All boilers are equipped for Brown Instrument Co. pyrometers, although only one is installed. These will

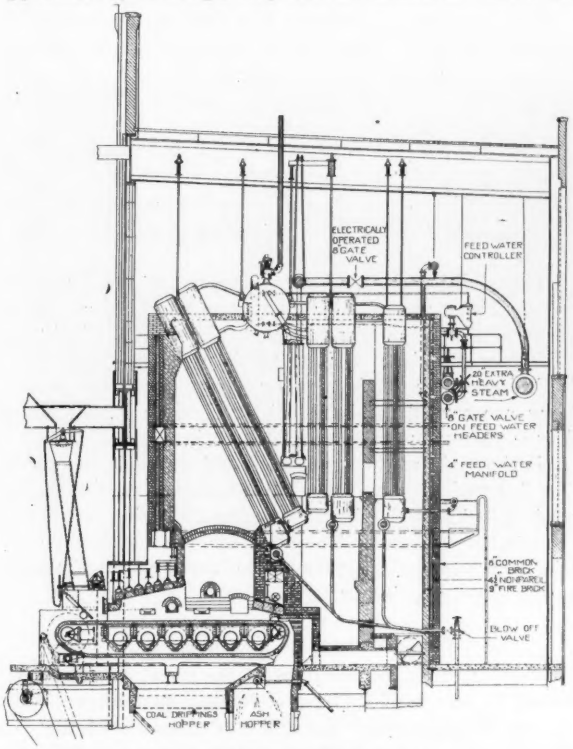


FIG. 9. SECTION THROUGH BOILER

read the temperature in the combustion chamber and in each pass of the boiler.

Steam Lines from Boilers

Steam is supplied from each boiler into the main 20-in. headers by means of two 8-in. boiler headers. These headers take steam directly from the superheaters at the top of the boiler and are installed with a 7-ft. radius, 90-deg. bend to the main 20-in. header. In each lead there is installed an 8-in. Edward, non-return valve and a Chapman gate valve electrically operated by the Dean system of control. This electric control feature is particularly worthy of note as it gives instant control of the steam supply from each boiler, from a single panel on the operating floor. Instead of having a man climb to the top of the boiler to close or open the boiler stop valve, an operation which in this plant would take at least 3 min., it is merely necessary to push a small button on the main control panel and the valve is opened or closed in an instant.

Simmonds piping is used throughout. All steam piping is insulated with H. W. Johns-Manville 3½-in. combination canvas covering. Leading to the yard for industrial purposes are two 20-in. high pressure and one 24-in. exhaust steam lines. One 16-in. header carries steam to the turbine room for the main units and a 12-in. header supplies the auxiliaries. The lead to the main turbine has interposed in its length, a large receiver to

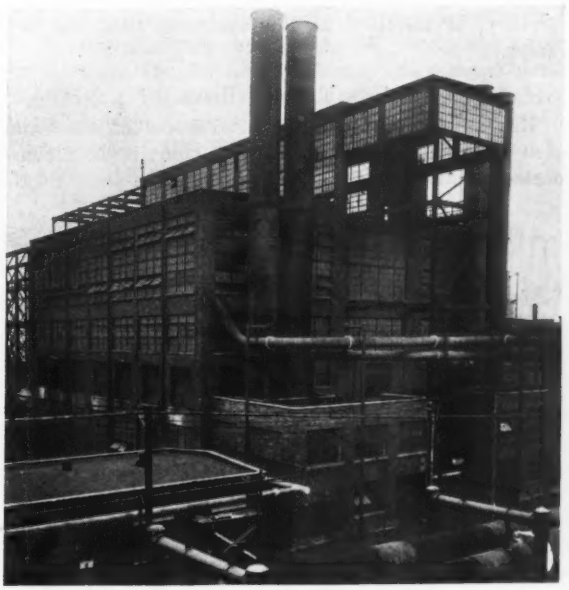


FIG. 10. THE NEW BAYWAY POWER PLANT. NOTE METHOD OF VENTILATING BOILER ROOM FLOOR

reduce the danger of water being carried over into the turbines. This receiver is located in the basement adjacent to the turbine room wall. The auxiliaries can be supplied independently from two boilers if desired. All headers are protected by Edward non-return valves.

Feed Water

Feed water is taken either from the river or from a private well. Because of its hardness all water used for boiler feed purposes must first be passed through a water treating system. This is a combination hot and cold system using lime and soda and aluminum or ferrous sulphate.

Two motor-driven, Cameron centrifugal pumps installed on the basement floor take suction from a 20-in. treated water main and pump the water to the four feed water heaters on the feed heater floor above. The latter are Swartwout heaters of the open type, each having a capacity of 7500 hp., and are heated by exhaust steam.

From the feed water heaters the water is delivered to the boilers by three turbine-driven boiler feed pumps, each with a capacity of 750 gal. per min. against a pressure of 225 lb. These are Cameron, three-stage centrifugal pumps direct connected to 165-hp. Westinghouse turbines. These units are fitted with Foster excess pump governors. The feed pump capacity is sufficient for the feeding of eight boilers of the type installed. As stated previously, the feed piping system is provided in duplicate, an arrangement which reduces the possibility of complete shutdown in case of damage to the feed system,

to the minimum. If one line fails the other will serve. Feed water is delivered to the economizers at a temperature of 212 deg. from the heaters.

In addition to the three boiler feed pumps and the two feed heater pumps installed on the basement floor, there are also provided two so-called service pumps which are used to pump treated water from the main feed supply line to another plant in the refinery.

For measuring the total amount of water used in the boilers, a 6-in. Venturi meter, made by the Builders Iron Foundry, is installed in the basement near the feed pumps.

The Turbine Room

Having described the main features of the boiler room we will now proceed to the turbine room which is located adjacent to the boiler house. The same careful

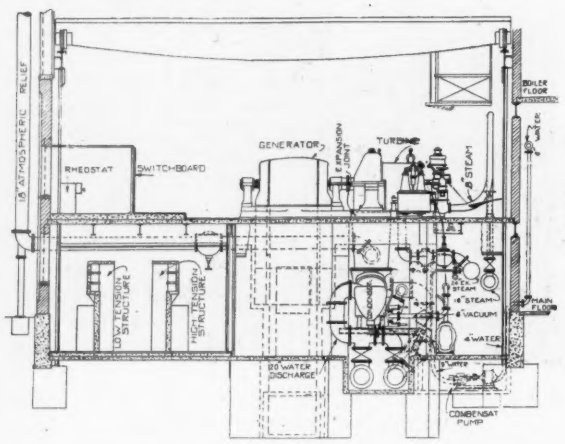


FIG. 11. ARRANGEMENT OF EQUIPMENT IN THE TURBINE ROOM

engineering which characterizes the design and construction of the boiler room is reflected also in the appearance of the turbine room. Light, airy, spacious, this room with its white tiled walls and spotless floor possesses an atmosphere of dignified simplicity commensurate with its importance as a part of the plant it serves. In the design of the entire plant, simplicity together with rigid requirements for economy of operation seem to have been the ruling factors, and to attain these ends no expense has been spared.

As may be noted from the accompanying photographs and drawings, the turbine room is rectangular in shape, 110 ft. in length and 56 ft. in width, provided on three sides with windows, and with walls of white enameled brick.

The ceiling is of concrete, painted white, supported by a steel truss construction. Powerful incandescent lighting units supended from the ceiling provide for illumination at night. For handling the heavy machinery, a 25-T. Champion electric crane is installed. This, as may be noted, spans the width of the room and travels the full length of the building.

All generating equipment is located on the side of the room towards the boiler house to simplify the running of steam leads and water connections. The switchboard is mounted on a raised portion of the floor about 2 ft. above the turbine room floor proper, to enable the operator at the board to obtain better view of the equipment on the floor.

Turbine Room Equipment

At the present time, there are installed two main turbo-generating units. Both of these are Westinghouse machines rated at 3750 kv.a., 6600 v., three-phase, 60 cycles, 328 amp. per terminal and operate at 3600 r.p.m. These units are of the bleeder type; one, however, is arranged to bleed out and the other to bleed either in or out.

It is contemplated to install some time in the near future another Westinghouse turbine unit, rated at 1000 kw. delivering three-phase current at 25 cycles. This machine is now being used in another part of the refinery but will be moved to the new power house.

Two frequency changers and two motor generator sets are installed. These are all of Westinghouse manufacture, the former being rated at 750 kv.a., 60 to 25 cycles and the latter at 290 hp., 6600 v., 60 cycles to 250 v. direct current.

Two exciter units are provided, one consisting of a 147-hp., 440-v., 60-cycle induction motor direct connected to a 100-kw., 125-v., 800-amp. generator, and the other a Westinghouse turbine-driven unit, also rated at 100 kw., 125 v.

Ingersoll-Rand surface condensers serve the main units. These are of the latest type, carrying a normal vacuum of 28 in., and using about 5,000,000 gal. of cooling water per day. Salt water is used for condensing. If desired these condensers may be connected in series. They are served by Ingersoll-Rand, class F. R., steam driven vacuum pumps, size 22 by 8 in.

Badger air washers are installed on each generator. The fan which drives the air through the generator and washer is integral with the generator, being a part of the rotating element. The air after passing through the windings and cooling them is delivered to the furnaces as described previously.

Electrical Features

Distribution and control of electrical energy is effected by means of a 47-panel vertical switchboard built by the Westinghouse Electric and Manufacturing Co. This board is a standard construction, the panels being of black slate supported on angle iron framework. It is divided into three sections, as follows: The first section consists of six panels, controlling the future 1000-kw., 25-cycle generator, the 25-cycle feeders and the low tension side of the 25-cycle transformers. The second or middle section consists of 24 panels and controls all 2300 and 6600-v., 60-cycle feeders and generator circuits, the high tension side of the 25-cycle transformers and the exciter and motor generator sets. The third section, consisting of 11 panels, takes care of the 440-v. alternating current circuits and the 250-v. direct current circuits.

Ten panels are hand controlled through levers and bell cranks, these being the low tension (440-v.) feeder panels. All high tension generator and feeder panels are fitted with remote control apparatus. There are two voltage regulating panels for the main turbo-generator exciters. These regulators are the Westinghouse type AN-4 and AF-7 rated at 100-120 v. alternating current 25-60 cycles. The main generators are provided with temperature indicating coils in the windings. All synchronizing is done from the switchboard.

In the basement directly underneath the switchboard is located the high tension bus structure. This is entirely of concrete and is one of the first of its kind to be installed in an industrial plant. They are common enough in central station plants, but are relatively unknown in industrial plant installations.

Each phase of each bus is in an entirely separate compartment. The disconnecting switches and the instrument transformers, as well as the oil circuit breakers are also installed in separate cells. Each cell is closed by a fiber cover or door. These doors are plainly labeled and the fastenings are so arranged as to prevent the door of a certain compartment from being changed, accidentally, to another compartment. There can thus be no accidents due to doors of high and low tension compartments being transposed.

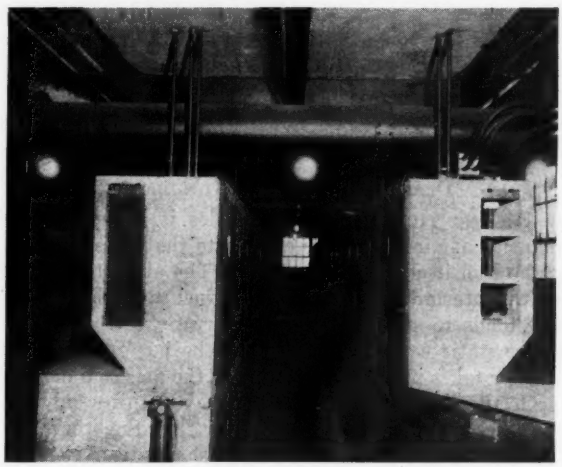


FIG. 12. BUS BAR AND OIL SWITCH STRUCTURES IN THE BASEMENT

All remote controlled oil circuit breakers are of the solenoid operated type and range in size from 300 to 2000 amp. A storage battery is installed for furnishing direct current for operating the control circuits.

Transformer equipment consists of six General Electric Co. transformers, three of which are three-phase, 25-cycle units and the other three, three-phase, 60-cycle units. The 25-cycle units are rated at 500 kv.a., changing the voltage from 480 to 2300 and the 60-cycle units at 333 kv.a. for changing from 6600 to 440 v.

Conclusion

This description would not be complete if attention were not directed to the meter room, a view of which is shown in Fig. 4. On the board shown at the left are installed 49 Republic recording and integrating flow meters, for measuring the amount of steam and water used by each division served by this plant. At the right is shown the panel on which is mounted the remote control equipment for operating the electrically controlled steam valves.

There are numerous other meters and recording instruments installed throughout the plant, all of which aid in keeping tab on the output. The records provided by these instruments are carefully inspected and interpreted, and the information applied towards increasing the operating efficiency of the plant.

While this power plant is only one among a number of others supplying power to the refinery it is the largest and therefore the most important. The principal electrical load on the plant consists of five 1000-hp. Westinghouse synchronous motors, direct connected to Cameron centrifugal pumps. These pumps are used for pumping salt water throughout the refinery for condensing purposes.

In concluding this description, we wish to acknowledge our indebtedness to the engineering department of the Bayway Refinery and to Geo. W. McKnight, of the Standard Oil Co., for assistance and privileges extended in gathering information and data for this article. All engineering on this plant was done by the engineering department of the Refinery which also superintended the construction.

Nitrogen in Transformer Eliminates Danger from Explosion

SARGENT AND LUNDY, consulting engineers, of Chicago, representing the Middle West Power Co., have purchased from the Westinghouse Electric and Manufacturing Co. a 25,000-kv.a. bank of power transformers which incorporate an entirely new principle in transformer design, claimed to eliminate any possibility of the explosions which sometimes occur in large transformers. These transformers are to be installed in the Grand Tower Illinois Station of the Middle West Power Co.

Many months of study have been spent on the problem of improving existing designs and this study has finally led to several new and important inventions. Large quantities of insulating oil are used in power transformers. While this oil is specially prepared for the purpose and ordinarily represents a very small fire and explosion risk, it sometimes happens that peculiar combinations of circumstances bring about rather serious explosions with transformers as heretofore constructed.

This new principle consists of filling the transformer case above the oil level with nitrogen, which is a harmless and inert gas, that is, incapable of forming an explosive mixture with oil vapors arising from the oil. The nitrogen gas used is generated in an ingenious device of simple design which is attached directly to the transformer tank. This generator works automatically to keep the space above the oil level always full of the protective nitrogen. No oxygen, which is the element needed to produce explosions or start a fire, can enter or be present in the tank. A big feature of the new invention is that this protective layer of inert gas above the oil level acts as a cushion or buffer to take the shock of any sudden pressures that develop under the oil level if there should be a short circuit or any defect in the transformer windings. An electric arc under the oil level, if it should occur, can produce a tremendously quick pressure in a tank. The sudden impact of this pressure against the walls and cover of a transformer tank which is completely full of oil, has been known to burst the tank and cause a serious interruption of service to electric power and light users. This cushion of nitrogen gas is easily compressed and it is enough of a buffer to take the brunt of the explosive pressure and save the tank from injury.

Draft Control Essential to Use of Moist Fuels

AIR MUST BE SUPPLIED THROUGH FUEL BED AND INTO GAS SPACE; MEANS EMPLOYED FOR CONTROL OF DRAFT. BY ZUCE KOGAN.

FURNACE DRAFT is always one of the main factors in the efficient utilization of fuel, yet it is the most delicate and most variable problem with regard to its proper supply and application. This is therefore of greatest importance with almost any fuels, while with moist fuels it becomes of still greater importance. This

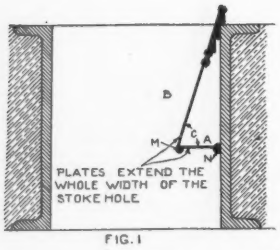


FIG. 1

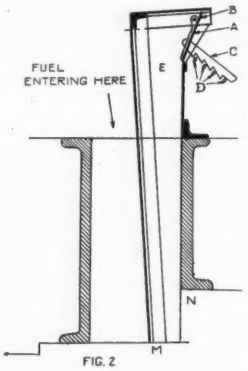


FIG. 2

FIG. 1. STOKEHOLE DEVICE FOR CONTROLLING AIR SUPPLY TO FURNACE RUN AT LOW RATINGS

FIG. 2. MEANS FOR CONTROLLING AIR SUPPLY THROUGH STOKEHOLE AT HIGH RATINGS

is due to the characteristics of the different moist fuels and to the different and complicated designs of furnaces.

Considering the different characteristics of the moist fuels, we know that every kind of fuel has different percentages of moisture and requires a particular regulation of air according to its moisture content. Not only so, but the same kind of fuel may have different quantities of moisture within a given quantity of fuel. Considering a heap of very moist fuel exposed to the atmosphere in the summer time or in the boiler room for a few days, we find the upper layer of the fuel heap to be reduced to a great extent in its moisture content. Moreover, the greater the moisture content of the fuel, the greater the difference between the upper and inner fuel layers of the heap, and the greater the care for the proper handling of draft according to its moisture content.

Considering the different furnaces, it may be said that the stokehole, the grate, the brickwork, general furnace design, and even the type of boiler greatly influence the draft. The stokehole introduces a great quantity of air which affects the combustion according to the shape, position and arrangement of the stokehole. The grates have different air apertures, air regulators, and fuel bed thickness, all of which affect to some extent the draft. The brickwork influences the manner of mixing the gases with the air, the direction of flow, its ignition, etc., while every furnace arrangement gives new draft conditions. Even the kind of boiler affects the draft according to its type, water tube or fire tube.

Enumerating what we expect to accomplish with proper draft, we know that it must supply sufficient air for the complete combustion of fuel into CO_2 and to distribute the air properly for the mixing with the gases when at the necessary temperature to enter into the combustion process. We are able to supply the necessary quantity of air, but we find great difficulty in applying it properly to moist fuels. Fuel of high moisture content subjected to an intense draft, that is, to the rush of cold air under the fuel-bed, is likely to be chilled below the point of ignition. The draft is easily seen to be very delicate to handle with moist fuels, as although there is a possibility of extinguishing the fire, it is, on the other hand, necessary to supply air in sufficient quantity in order to burn the fuel economically. For this reason, it becomes the aim of the discussion to investigate the effect of the furnace design on the draft questions, as applied to moist fuels, and this therefore will be considered by referring to: 1. Draft through the stokehole. 2. Air supplied to the fuel bed. 3. Air supplied to the gases. 4. General effect of draft.

DRAFT THROUGH THE STOKEHOLES

PASSING THROUGH the stokeholes is always a great quantity of air supplying oxygen to the gases and some to the fuel itself for combustion. The air entering during the intermittent feeding of the fuel through the stokehole tends to stratify and pass directly to the chimney before static equilibrium between the hot gases and the cold air takes place. This prevents the air from descending to the fuel bed and therefore the air unites only with the gases rising above the fuel layer. On the other hand, the fuel being of varying sizes and shapes, causes a great many air-filled spaces in the fuel-bed on the grate. This air is available for combustion of the fuel. The quantity of air carried in these air pockets depends to a great extent on the kind of fuel used; with some fuels, the quantities may be very large.

Many fuels are of a spongy nature, and, unless compressed, bring in a great amount of air with them. For this reason, we must assume that: (a) the total air entering the stokehole is equal to that rushing in at the times of feeding the fuel and that carried within the fuel during the charging, and (b) the air entering the stokehole is partly to mix with the gases and partly to unite with the carbon when still on the fuel layer.

Considering the first (the second having been considered in a preceding article), it may be said that the only way to estimate the amount of air passing through the stokehole is by proportioning it to the volume of the fuel fed. With the knowledge of the greatest quantity of fuel that can pass per hour through the stokehole, we can ascertain the amount of air that is passing through the stokehole for any rate of feeding. As we do not always use the full rating, we subtract the quantity of fuel fed from the quantity of fuel possible to feed and we thus know the time the stokehole aperture was allowing air to pass through it.

From such a calculation, we find the amount of air passing through this stokehole to be indirectly proportional to the boiler rating, as the smaller the rating the greater the time the stokehole aperture permits air to pass through it. This is just the reverse of what is

desired because we want the quantity of air proportional to the rating.

This shows the impracticability of the open type of stokeholes, and therefore some means are required to hold the quantity of air supply within the necessary limits. Considering, therefore, the question of draft again, we are to assume that the total draft supplied to the fuel is equal to that passed through the stokehole plus that passing through the grates (if no other air entrances are in existence with the furnace installation). Now, having determined the quantity of air passing through the stokehole with a given boiler rating, we subtract this from the total quantity of air to be supplied to the fuel and obtain the quantity of air to pass through the grate or the fuel bed. For this reason, the correct amount of air entering the furnace can be obtained by regulating the amount of air passing the grate, and this therefore obliges the use of air regulators under the grate when ordinarily open stokeholes are employed for the feeding of fuel.

As mentioned, such a procedure serves for applying the air to the furnace but not for distributing it in the best manner for the proper mixing of air with the carbon of the fuel, for economical combustion. For in this case we base our procedure on the stokehole, that is, we find the amount of air passing through the stokehole and we allow the rest of the air to pass through the grate without regard to whether the air passing through these places is well proportioned for the most satisfactory combustion. Practically, however, this gives a bad effect on the fuels, especially when the boiler ratings are too low or too high, therefore we find it more desirable to have the air regulated when passing the stokehole instead of when passing the grates or fuel beds.

Considering the case of very low rating, we know that the air is passing in excessive quantities through the stokehole and but little through the grates. Now as the air from the stokehole does not meet the fuel on the grate, it results that the air on top of the fuel bed is insufficient to keep the furnace temperature high enough to ignite the gases, and the gases are therefore leaving the furnace unburnt, although the flue gas contains free oxygen. The best possible procedure is to reduce the stokehole aperture sufficiently to suit the particular case.

Automatic doors at the stokeholes are of advantage, but they are not adaptable with all kinds of fuels. A good arrangement of the author's design for use with the rectangular stokeholes is shown in Fig. 1. Two plates A and B swing on shafts M and N in such a manner that angle C can be varied by raising the plate B; in this case the adjustment of plate B is done by gripping with its teeth D into the ends of the stokeholes. This therefore permits regulating the stokehole aperture at will, and augmenting the supply of air under the grate.

Considering the high rating, which is more usual than low rating, we meet again considerable trouble with our fixed aperture of the stokehole. In this case, the whole question of air supply is reversed, as the stokehole will pass a small amount of air while the grates, the largest amount. Taking into account that the rush of air under the very moist fuel bed tends to extinguish the fire, the excessive amount of air in this case surely gives a bad effect on the combustion. Regardless of the fact that with higher rating the rush of air under the grate may be increased to a greater extent with economical results, the quantity of air practically necessary to pass through the grate at very high rating is so great that imperfect combustion will result with fuel whose moisture is higher than 35 per cent. For this reason, additional air is always required at the stokehole so as to supply more air for the gases, instead of straining an excessive amount through the grate. The arrangement shown in Fig. 2 consists of a regulator placed at the aperture of the stokehole and designed to admit the extra desirable quantity of air during the ratings. The door A swinging at point B is fitted with an oscillating handle C having four teeth D, D, D, D. These teeth leaning on the seam E are provided with four apertures for air regulation.

Air Applied to the Fuel-Bed

With complicated draft questions it is always preferable to consider the air distribution and mixtures, that is, utilization of air in the fuel bed and in the gases arising from the fuel bed. This leads to the consideration of the two distinct combustion zones. Both combustion zones are essential, but it is always preferable to have the fuel burned completely in the first combustion zone, i.e., to consume all the liberated carbon to the fuel bed. Briefly speaking, if we were able to accomplish this, we would obtain a more economical combustion of the fuel. As to what prevents us from keeping the maximum combustion of fuel at the grate, we know it to be due mostly to the air, which did not mix well with the carbon. Now, as the quantity of air passing through the fuel bed is limited, due to its tendency to extinguish the fire, it is therefore understood that the air at the fuel bed is insufficient to produce complete combustion here.

To complete combustion, it is sometimes practicable to allow a quantity of air through the bridgewall at the rear end of the furnace, as shown at A, Fig. 3. Air admitted here comes in contact with the fuel and, entering into the furnace from the rear end, is much cooler than the gases inside the firebox. The action of the air causes rapid oxidation of the upper fuel layer. Nevertheless, it becomes important to retain this air in contact with the fuel bed and prevent it from flowing away, due to draft intensity, with the gases. Arches are therefore designed to insure these conditions.

Such arches are placed just above the fuel bed, the height depending on the rating which is expected. This arch will also cause the gases to mix better and to ignite quicker due to the heat radiated from the arch. Comparing the value of air supply through and above the grate or fuel bed, there are a great many good reasons to believe that when air passes through the fuel bed it mixes better with the gases than when supplied just above the fuel bed. But as the quantity of air to be admitted through the grate is limited, it is undoubtedly good procedure to supply the air above the fuel bed. The special advantage is that it permits attaining higher ratings than possible with the feeding of air through the fuel bed alone.

Air Supplied to the Gases

Air for burning the gases needs greatest consideration in the efficient combustion of fuel, as when these gases pass off unburnt or as CO, there is a great loss of fuel. As already mentioned, it is far preferable to consume the gases at the fuel bed, but this was explained

to be impossible due to the difficulties met in supplying the air in the most favorable manner. Some gases rise from the fuel bed and by the force of the draft tend to flow to the chimney unburned.

Considering the stokehole, it may be said that air passing through it has a tendency to mix with the gases rising from the fuel bed, therefore it is of advantage to have the air supplied through it. In the same manner, we may say that for slow feeding of fuel the air from the stokehole is sufficient to consume the gases. With high rating, however, it was pointed out that the quantity of air passing the stokehole decreases as the rating increases and therefore the supply of air for the gases becomes insufficient. For this reason, some air regulators, as illustrated in Fig. 2, fitted to the stokeholes, are used for this purpose. As may be noted from the drawing, the end M extends lower than N. The reason for this arrangement is that the fresh layer of the very moist fuel is on top near the stokehole and is subjected to drying by the heat of the furnace. If now the cool air will flow on it, it will prevent it from absorbing the heat for drying; that is, the cool air rushing on

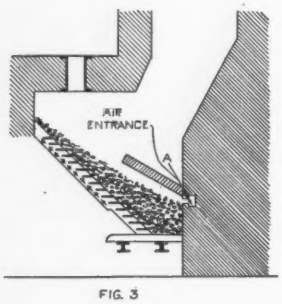


FIG. 3

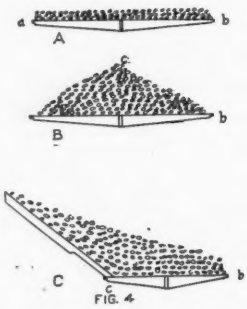


FIG. 4

FIG. 3. METHOD OF ADMITTING AIR AT THE BRIDGEWALL
FIG. 4. FORMS OF FUEL BEDS USED IN BURNING MOIST FUELS

it will not permit the heat of the furnace to reach it for drying.

General Effect of Draft

Draft with moist fuels is influenced a great deal by the furnace installation and by the type of boiler. The slightest change in the furnace affects to some extent the question of air. The most important consideration is, however, the position of the fuel on the grates. Considering the three fuel beds of Fig. 4 A, B, and C, we have in each case the air passing differently, which requires consideration of the distribution of draft for the particular fuel arrangement. Considering Fig. 4A, we have the fuel spread uniformly over the grate area and the air passing uniformly under the grate. Referring to Fig. 4B, we have only, say one-third of the grate area admitting air. The greatest percentage of air comes through the grate at the sides or ends and diminishes near the center of the fuel cone. Considering Fig. 4C, we find the fuel bed on the grate to be different from Fig. 4B, due to the fact that, say, two-thirds of the fuel is exposed to the air under the grate. The passage of air, its mixing and its igniting is greatly influenced by these fuel layers and therefore the question of draft must be considered accordingly.

Considering the influence of boilers on draft, it may be said that it is quite difficult to generalize from a few experiments that all moist fuels are affected by the type of boiler, but we may safely say it is true with the greatest number of moist fuels used under the inclined type of stokers. Experiments conducted with many moist fuels and with a given furnace installation, but different boilers, showed that the intensity of draft must be varied, according to whether the boilers are of water-tube or fire-tube types.

In order to give a better account of these it may be of interest to mention the experiments conducted by the well known French chemist, Mr. Pellet, on bagasse

RESULTS OF TESTS ON DIFFERENT BOILERS USING BAGASSE AS FUEL

Moisture per cent in fuel	CO_2	Pressure of steam in kilograms per sq. centim.	Degrees Centigrade: Temp. of Water	Temp. of Air	Temp. of Gases	Water evaporated per klgr. of fuel	Fuel burnt per sq. meter of grate per hour.	Equivalent Evap.	Draft of boiler in millimeters
Types of Boilers:									
Babcock Water Tube Boilers—									
48.3	15.3	7.3	21.5	20.5	233	435	1.84	4.35	6.0
50.0	14.3	7.6	21.0	24.0	215	410	1.86	4.47	5.6
49.5	13.0	7.2	19.0	19.0	240	615	2.05	4.97	12.0
50.0	13.0	7.0	18.5	23.0	245	704	1.97	4.84	13.0
Stewart Fire Tube Boilers—									
54.7	12.5	6.5	20.0	25.7	220	540	1.76	4.75	12.0
50.5	15.2	7.3	19.0	20.0	235	607	1.96	4.76	12.0
52.0	15.2	7.2	19.0	21.5	210	464	2.00	5.11	6.0
50.0	14.8	7.5	19.0	24.0	230	565	1.93	4.72	12.5
52.0	14.0	7.1	20.5	23.0	210	416	2.00	5.10	6.0
52.0	15.8	7.4	20.0	24.0	225	444	1.95	4.98	6.0
Fives Fire Tube Boilers—									
50.0	15.0	7.2	21.0	28.0	215	535	1.73	4.21	10.0
47.5	17.0	7.5	22.5	24.0	200	380	1.84	4.26	4.0
48.0	15.0	7.5	21.5	25.0	200	430	1.95	4.59	4.5
46.5	10.0	7.7	24.0	29.0	225	285	2.22	5.25	4.0

fuels and on inclined type of stoker. The table gives briefly the results of his experiments. In this table the draft is placed next to the equivalent evaporation so as to show the exact effect of the different boilers with a given draft on equivalent evaporation. From this table, Mr. Pellet concluded that the equivalent evaporation increases with the decrease in draft when under a fire-tube boiler and that this is just the contrary with the Babcock boilers.

U. S. Civil Service Commission announces the following open competitive examination: Laboratory assistant, Junior Grade, and Senior Aid, Feb. 14, to fill vacancies in the Bureau of Standards, Department of Commerce, Washington, D. C. The entrance salary for laboratory assistant, junior grade, is $1000 a year, plus the increase of $20 a month granted by Congress, and for senior aid is $900 a year, also plus the increase. The written examination consists of physics and chemistry, mathematics (through trigonometry) and mechanical drawing. The element of education and experience is weighted at 50 per cent, or one-half of the total examination rating. The Bureau of Standards covers a wide field of work in physics, chemistry, engineering, and industrial technology, and offers unparalleled opportunity for the study of a profession. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or secretary of the board of U. S. civil service examiners at the postoffice or customhouse in any city.

Many Schemes Are Used in Handling Ashes

OPERATING CONDITIONS TO BE MET AND FINAL DISPOSITION OF ASHES MUST BE CONSIDERED IN LAYING OUT AN ASH HANDLING SYSTEM. BY JOHN HUNTER AND ALFRED COTTON*

ASH HANDLING is just as important as coal handling. It is a simpler problem only to the extent that there is less ash than coal, but the coal disappears while the ash accumulates. The ash must be got rid of or the plant will be put out of commission.

Except that there are several standardized types of conveyors, classification of methods of ash handling is not convenient and would serve no useful purpose. Each problem must be considered entirely according to its particular circumstances. The methods of offering the ash in the first place, the general conditions to be met, and the final disposition are all so varied and the possible combinations of each are so numerous that each installation is different from others in some respects.

No doubt the most rudimentary method is that in which the ashes are hoed out of the fire doors and ashpits onto the firing floor and are shoveled into wheelbarrows which are dumped outside the boiler room, either to fill up depressions or to be carted away. In some cases, the ashes are shoveled into industrial railway cars, which are then pushed to the dumping point. In some existing plants, a basement is out of the question, and even if a change were made to stoker firing, the ashes would still have to be hoed out of the ashpit. But the wheelbarrow can be replaced by either a mechanical or air conveyor.

USE OF CHAIN CONVEYOR

FIGURE 1A is a cross-section of a block-chain conveyor running in a trench under the firing floor. The ashes are hoed on to the grating, through which they fall down the chute to the bottom of the trench. They are then drawn along by the chain, discharging into a bucket elevator as illustrated in Fig. 1B or onto an inclined chain conveyor carrying the ash into an elevated storage hopper.

Where there is a plentiful supply of water, a flume may be carried along under the firing floor and the ashes raked into it through openings. This is a very simple method, but it is seldom that a natural water supply and sufficient fall from the plant are available adequately to dispose of the ashes.

When the boiler room is considerably below the ground level the problem is more complicated. In such cases there will seldom be a basement below the boiler room, partly on account of the expenses of further excavation, and often because of difficulties with building foundations and with water. Good examples are the boiler rooms of office buildings and hotels, where the boilers are generally a considerable distance below the street level and the building is closely surrounded by streets and other buildings. Whatever the final disposition may be, the ashes are invariably removed from the vicinity in motor or horse-drawn trucks. Here the important consideration is principally that of hoisting the ashes from the boiler room to the street. The crudest method is to load the ashes into ash cans and hoist them by hand-operated block and tackle to the street. This entails high labor cost.

In the isolated heating plants of the Union Electric and Power Co., in St. Louis, exactly this problem ex-

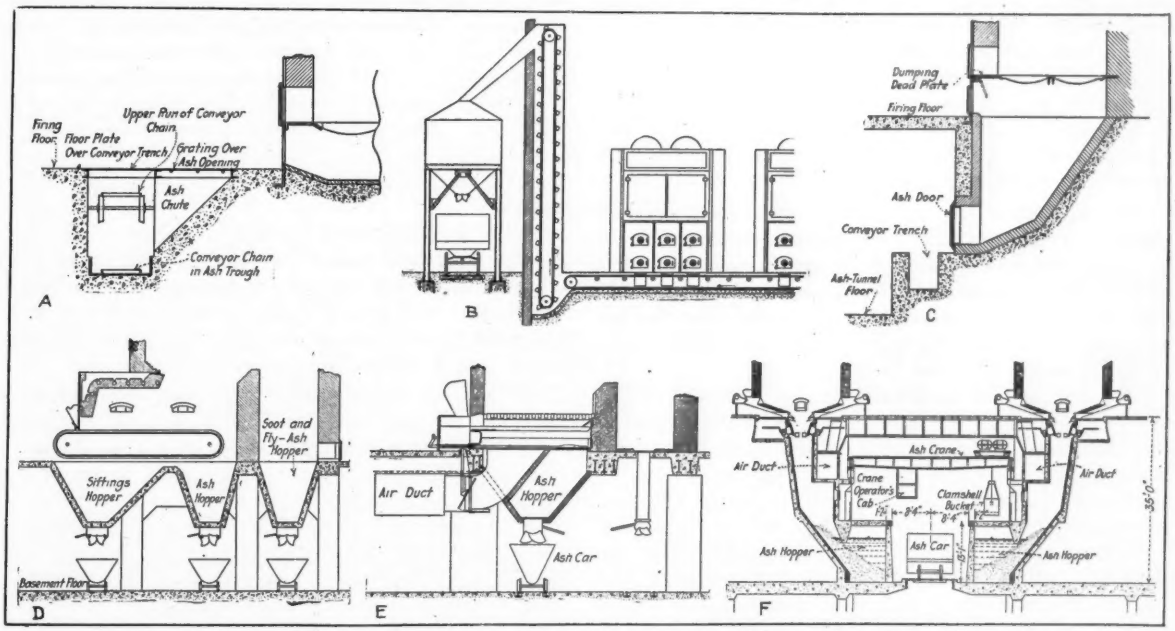


FIG. 1. WHETHER A PLANT IS LARGE OR SMALL, ASHES SHOULD BE HANDLED EFFICIENTLY

A. Block chain conveyor running in a trench, and the firing floor is sometimes used. B. Bucket elevator and ash bunker used with the conveyor shown. C. Simple form of hopper ashpit for a hand fired furnace. D. In this layout hoppers are provided for ashes, coal siftings and soot. E. Hopper ashpit for a side feed stoker. F. Water sealed ash hopper used in the Springdale station of the West Penn Power Co. Water seal prevents ingress of air, and permits removal of ashes by means of clamshell bucket at all times.

* Abstract of a paper on Ash Handling, presented before the annual meeting of the A. S. M. E., on Dec. 5.

isted. It was solved in the following simple manner with some saving in labor: The ash trucks were equipped with a davit just like a regular boat davit on shipboard. A small winch with a 4-in. barrel geared to a ¼-hp. electric motor was mounted at the side of the truck. A 3/16-in. steel wire rope was attached and wound on the winch barrel, and passed through a pulley block hanging from the head of the davit with a hook at the free end. The davit was simply a length of 1½-in. pipe bent to shape with the head end flattened to facilitate bolting on the lug of the pulley block. Current for the motor was conveyed by a flexible cord from a socket in the plant and snapped to the motor when the ash truck arrived. Opening the sidewalk cover, the hook was dropped and the first ash can attached, quickly hoisted to the davit head, the davit swung around and the ash can dumped into the wagon, and then returned to the basement. With this cheap and simple rigging the truck was quickly loaded, the flexible cord disconnected from the motor, the sidewalk cover closed, and the truck driven away. The whole operation was completed in a few minutes with greatly increased economy in handling.

In some instances, the air conveyor (the so-called steam-jet conveyor) has been used advantageously in hospitals, hotels and office buildings in crowded parts of cities, but it is not always applicable. Unless certain precautions are observed, such as connecting the air discharge into the chimney, the noise may entirely prevent the use of the system.

Another method is the "post box" elevator. The ashes are stored in the boiler room until the arrival of the ash truck. The elevator, which is of the bucket type, has a telescopic housing which is pushed up through the sidewalk opening and the chute extended to discharge into the truck. When the truck is filled and the elevator stopped, it is withdrawn below the sidewalk and the cover closed over the opening. The casing of the elevator is telescopic to allow of its retraction below the sidewalk, and the bucket chain is so designed as to allow the slack to pile up in an orderly manner at the bottom without becoming entangled.

Where conditions allow, an ash-storage hopper may be constructed within the building and a closed ash chute temporarily extended over the sidewalk to the ash truck. The storage hopper may receive ashes from a bucket car and whip hoist, a bucket elevator, or an air conveyor. It is not often that this method can be employed. The purpose of the building may entirely prevent the use of such a hopper, and the temporary extension of the ash chute over the sidewalk would not be permitted in the better or more crowded streets.

Hopper Ashpit Saves Labor

As the first operation where labor can obviously be saved is in avoiding hoeing and shoveling ashes at the outset, this leads naturally to a consideration of the hopper ashpit. The hopper ashpit is regular practice in the modern plant. Its size and general design will depend primarily upon the manner in which the ashes flow into it, the method of removal, and also upon the system of draft. The design begins at the top to suit the stoker.

In hand-fired, forced-draft anthracite plants the top of the hopper will conform to the whole grate area. With stationary grates fine ash is falling constantly over the whole area. As the fires are hand-cleaned, a dumping deadplate will keep the ash away from the firing floor and allow it to fall directly into the hopper, the forced draft being temporarily shut off. With dumping grates the ash will also fall from most of the grate surface. The ashpit will most probably be a storage hopper, which will be emptied at intervals with the forced draft shut off. Large capacity is necessary because of the high percentage of ash in this fuel. The discharge door must be airtight to avoid increasing the cost of generating the forced draft and the possible reduction of ashpit pressure's lowering the boiler capacity. If it can be dumped directly into railroad cars, the basement being deep enough for this purpose, the hopper can be quickly dumped through bottom doors. Where conveyors are installed it is usual to use a side door and work the ashes out gradually into the conveyor to avoid choking it, as would happen with a straight dump. Figure 1C illustrates a layout of this kind. The conveyor will occupy the trench in front of the ash door. It may be mechanical, bucket or chain, or air or water, and is therefore shown schematically only.

With forward-travel underfeed stokers, chain-grate stokers, front-feed inclined stokers, and others the ashes are dumped at the rear of the furnace and the top of the hopper will be the width of the fire but of small dimension from front to rear to accord with the stoker dump. This reduces the capacity for storage.

With chain-grate stokers a hopper should also be provided for fine coal which sifts through the grates before ignition. Such an arrangement is shown in Fig. 1D. This coal is dumped into some means of conveyance to be returned to the stoker coal hoppers.

Side-travel underfeed stokers dump at each side of the wind box for the whole depth of the fire. Hopper ashpits for this type of stoker may therefore have greater storage capacity since the top of the hopper extends to the front of the boiler. Figure 1E illustrates an ashpit of this kind. In the Combustion Engineering Company's Type E stoker a valve is provided to admit forced draft to the ashpit in order to burn out the ash more completely before dumping, and therefore the ashpit dump doors should be reasonably airtight.

In discussing the amount of storage required, it will be noticed that there are frequently two places where the ash is stored: in the ashpit and in the elevated ashbin, if there is one. In some instances small capacity may be sufficient, owing to storage being taken care of outside the ashpit. The method of conveyance from the ashpit will have considerable bearing on the ashpit capacity necessary. But 24 hours' capacity should usually be provided in case of breakdown of conveyors, etc. Consequently some of the attributes of different methods of conveyance which bear on ashpit capacity should be mentioned here. The largest ashpit capacity will be requisite with conveying systems which are operated intermittently. These will include instances where ashpits are dumped into standards or industrial railroad cars, or into conveyors which might be choked by the direct dumping of an accumulation containing large clinkers and therefore need hand feeding or at least manual attention. Where a continuous-conveyor system is used the ashpit may be much smaller,

and sometimes the ashpit becomes simply a funnel or chute to guide the ashes into the conveyor.

Since the required capacity depends upon the amount of ash that accumulates between emptyings, it is controlled by the rate of firing and the percentage of ash in the coal. Multiplying the weight of coal burned between dumpings by the percentage of ash and allowing 40 lb. per cu. ft. gives the storage space required. Allowance must be made for unburned coal coming in with the ash, for neglect to empty regularly, for possible increase in the load and consequently in the rate of combustion, and for possible change to dirtier coal. The careful engineer will make the capacity of his ashpits perhaps 50 per cent greater than the calculations show, or even more. Also, sufficient space should be left above the top of the ashes in order to prevent burning and breakage of stoker mechanism.

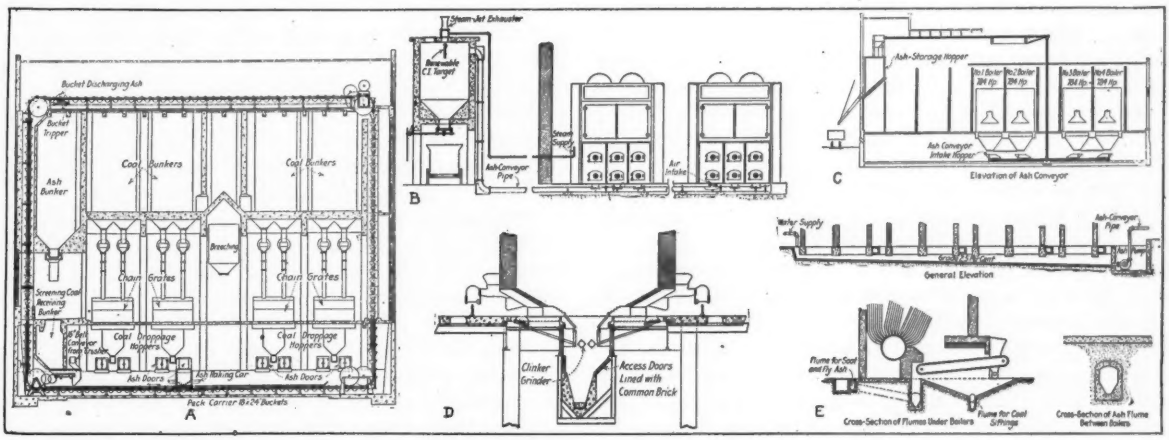


FIG. 2. MECHANICAL CONVEYANCE OF ASHES AFFORDS AN OPPORTUNITY FOR INGENIOUS SCHEMES TO MEET PARTICULAR OPERATING CONDITIONS

A. This is a basement plant and the mechanical conveyor handles both coal and ashes. Coal is delivered by trucks to the receiving bunkers and ashes are loaded from the ash bunker. B. Vacuum method of conveying ashes in which the air current is created by a steam jet exhauster located in the ash bunker. C. Another method of air conveyance in which steam nozzles are used to produce the air current. In this installation auxiliary hoppers feed the ashes into the pipe line. D. At the Hell Gate station water flumes carry the ashes to a pipe line which discharges into a settling tank. E. Another method of water conveyance showing the type of flume used.

Hopper-Ashpit Design

Ash hopper sides should slope at not less than 45 deg. in any case, and a minimum of 50 deg. with the horizontal is preferable. If one side is vertical the opposite side may have the minimum slope; but where two opposite sides slope, neither should slope less than about 55 deg. If the slope is too small, arching of the ash is likely to occur and this will increase operating costs owing to the frequent necessity of encouraging the flow by breaking away the ash with bars poked up through the discharge doors. Where the width of the hopper would necessitate too great height to get these required slopes, the ashpit may easily be divided so as to have a number of discharge openings.

If a very small slope is used so as to get large capacity, access doors should be provided at the top of the slope so that the ashes may be pushed to the dump doors with a minimum of labor, and ample space should be left so that long ash tools can be wielded with ease.

Large discharge openings should be used, though their size depends to some extent upon the method of firing. When small anthracite is burned with sufficient steam in the combustion air, no clinkers are formed and the ash is in small pieces and easily dumped. Modern intensive firing of bituminous coal tends to cause the formation of large clinkers, and the openings should be large enough to pass these without having to break them into smaller pieces to allow dumping. In earlier installations, door openings about 18 in. square and even less were common, while modern practice required 30 to 36 in. as a minimum, with many instances of clear openings 5 ft. square.

In some instances the discharge door is in one of the sides of the hopper as in Fig. 1C and the attendant hoes out the ashes either into cars or conveyor. Whenever it can be adopted, however, the bottom discharge is undoubtedly the least costly in labor and well repays the added expense of the greater height of basement needed.

Height of the bottom of the hopper above the basement floor depends upon the systems of conveyance adopted. It is greatest where standard railroad cars are used, about 8 or 9 ft. to clear the cars and about 17 to 18 ft. if a locomotive must pass under. With industrial cars 5 or 6 ft. is sufficient, though a clear headroom of 6 ft. 6 in. to 7 ft. is preferable. With some conveyors it may be much less, but in any case there should always be sufficient vertical space to allow a bar to be pushed up into the hopper to clear away any obstruction. In designing new plants ample headroom should always be provided.

Where storage takes place in the ashpit, water spray pipes should be provided for quenching the ashes. These pipes should be near the top and sheltered from the incoming ash. Or a substantial spray ring may be used. Many prefer to make the hopper sufficiently large for the ashes to remain long enough to cool naturally. By allowing some ash to remain when dumping, for the new hot ash to fall on, the doors and lining are protected and the ash gradually cools without the use of water. If too much water is used, it will leak from

the dump doors and flow about the basement; and as it contains much fine ash in suspension, it will clog sewers and necessitate cleaning them frequently.

Hopper-Ashpit Closures

Hopper ashpits will usually be provided with doors to retain the ash and prevent the passage of air, and to allow of the ash being dumped or hoed out at intervals as desired. With hand firing and natural draft the doors need not be airtight so far as draft is concerned; but with chain grates and with closed ashpit forced draft the doors should be tight to avoid loss of air pressure and waste of blower power.

Inleakage of air may reduce boiler efficiency in some cases by excess air passing the fire through the stoker ash dump; and when forced-draft stokers are heavily loaded, gas may escape through the dumping doors. Where much combustible gets into the ashpit, either through carelessness or imperfections in stoker design, leakage of air through ill-fitting dump doors often causes sufficiently rapid combustion in the ashpit to result in damage to grates, hopper structure, or dumping doors. Airtight ash doors are therefore highly desirable in almost all cases.

There are several cases in which the dump openings may be sealed. The doors and faces may be machined, or the frame may be provided with a groove packed with asbestos rope, while the door has a rib or tongue which is squeezed into the asbestos packing by a cross-bar and screw spanning the door. The latter method has been used with satisfaction in vertical doors like that of Fig. 1C. The door and frame may sometimes be left unfinished with sufficiently well-fitting smooth-faced castings that will prevent much ingress of air. The doors should usually be lined with firebrick to prevent warping due to hot ashes lying on them soon after dumping.

Instead of using doors, closure may be effected by water seal. This method may be described as a U-tube with one leg forming the hopper ashpit while the other is open to the atmosphere and possibly to the entrance of a clamshell bucket. Water in the bend of the U-tube forms a seal and serves to quench the ashes.

Use of Water Sealed Ashpit

An excellent example of this method is illustrated in Fig. 1E, which is a cross-section of the boiler room of the Springdale Station of the West Penn Power Company. The operation of this system is simple. More than sufficient water for the seal is provided by the waste cooling-water from the clinker grinders. The overflow is from one ashpit to the next, until it is finally discharged from the last ashpit.

This system of ashpit requires considerable depth of basement; not less than 30 ft. from firing floor to basement floor. At Springdale it is 35 ft. and as deep excavation for foundations is necessary, extensions will probably have much deeper ashpits. These deep ashpits provide excellent storage. Actual test shows the present ashpits to have a capacity of three days' operation at 200 per cent continuous rating of the boilers.

Removal of ashes from the ashpits is by traveling crane and clamshell bucket, and is one of the most comfortable and easy jobs around the plant. One crane operator handles the ash output of the station in two hours per day.

That no combustible or corrosive gas escapes into the basement is a further advantage of this method. When boilers are being pushed with heavy loads, gas often escapes from hopper dump doors. Apart from discomfort and danger to those in the basement, considerable corrosion of ironwork often occurs. Such troubles are entirely obviated with the water-seal ashpit.

Uniflow Engine Principles and Design---III

A Study of the Uniflow Engine as Applied to the Steel Industry. By Fred William Bosch

In the iron and steel industry the trend of development of power supply has been to electrify every machine, up to and including the main rolls, and to concentrate the power generating apparatus in a central power house containing steam turbines in regions of cheap fuel, and gas engines (with an auxiliary steam turbine for overload) in regions of expensive fuel.

Into this stage of development was introduced the uniflow engine which, by virtue of its high efficiency, promises to change the trend of evolution.

In the steel works power plant the uniflow engine will have to compete with the gas engine and with the steam turbine. The gas engine uses 7500 to 9500 B.t.u. per i.hp.-hr. whereas the uniflow engine, running condensing, uses from 11,000 to 13,500 B.t.u. in the steam and more in the fuel gas, depending upon the boiler efficiency. There is, in consequence, little hope of "replacing" the gas engine by the uniflow engine.

Comparison on Rankine Cycle Basis

In comparing the engine and the turbine, the variation of steam pressure and of back pressure make it advisable to leave the B.t.u. basis and to introduce the Rankine-cycle efficiency, which means the ratio of the work actually produced from a unit weight of steam to the work that could be produced by the same weight of steam passing through the Rankine cycle. From a great number of published tests made on the best turbines, Prof. Trinks has formed the following averages for condensing operation:

Size of turbine, kw.....	500	1000	2000	5000	10,000
Rankine-cycle efficiency referred to brake hp.	0.62	0.66	0.71	0.77	0.82

For non-condensing operation the values are much lower.

Data furnished by the Stumpf Unaflow Engine Co., Inc., tests made by Prof. Trinks, and data from the Ames Iron Works and the C. & G. Cooper Co. indicate the following efficiencies from 3 lb. per sq. in. back pressure above atmospheric down to about 23 in. of vacuum:

Size of engine, kw.....	300	600

Efficiency:		
Saturated steam	71	74
100 deg. superheat	75	77
200 deg. superheat	78	79
For high vacuum (about 27½ in.):		
Saturated steam	58	62
100 deg. superheat	62	65
200 deg. superheat	66	68

These values may vary somewhat to one side or the other, but the general trend is apparent.

For non-condensing operation, for 100 deg. superheat, for moderate vacuum, and for sizes up to 1000 kw. the uniflow engine is more economical than the turbine. It will therefore find a place in comparatively small power plants and in such locations where 28 in. of vacuum or better is not attainable. It will also be preferred for generating direct current, because turbines, for generation of direct current, when directly connected, are too slow for best economy; if they are to operate at economical speeds, gears must be introduced.

For the driving of rolling mills the uniflow engine was compared with electric drive and with the older type counterflow engine. In comparison with electric drive, the steam engine does away with the electric generator, the switchboard, the transmission line and the motor, but takes undesirable piping into the mill. The elimination of the electrical part means that a comparison must be made of the Rankine-cycle efficiency of the engine to the Rankine-cycle efficiency of the turbine, including generator, transmission line and motor. Allowing the high efficiency of 92 per cent for the generator, 98 per cent for the transmission line and 92 per cent for the motor, it is necessary to multiply the turbine efficiencies by 0.83 for comparison with the direct-connected engine. This procedure furnishes:

Size of turbine, kw.....	500	1000	2000	5000	10,000
Rankine-cycle efficiency:					
Referred to motor shaft	50	54	59	64	68
Referred to mill shaft.	47	50	55	60	64

Values in the lower row were obtaind by multiplying the upper row by 0.965 × 0.965, this figure taking care of the efficiency of two speed reductions from the motor to the mill.

Study of the resulting values shows that the uniflow engine is ahead of the electric drive, unless the steel plant is so large and the load such that turbo-generator units of over 8000 kw. capacity can be installed.

The economy of the uniflow engine compared to that of the steam turbine electric drive, taken by itself, is not enough better to explain why the uniflow engine should fare differently from the compound engine. The Rankine cycle efficiency of good compound engines is practically the same as that of the uniflow engine, but there is one vital difference: to obtain that high efficiency the compound engine must have a small high-pressure cylinder (which cuts down condensation area), but the small size of the latter means a small overload capacity and quick departure from best efficiency for comparatively small changes of load. Figure 1 illustrates the water-rate-load-curve for a well-known compound engine. Comparison of this curve with the typical water rate curve of a 20 by 22-in. uniflow engine, Fig. 2, shows the latter curve to be much flatter, and this, in fact, is the unrivaled advantage of the uniflow engine. The uniflow engine is operated at a pressure of 143 to 148 lb., a superheat of 65 to 75 deg. F., a vacuum of 25 to 26 in., and a speed of 200 r.p.m.

Mill loads are notoriously variable, because variation in draft, temperature of steel, velocity of rolling, etc., all cause disproportionately great changes in resistance. It is not possible to foretell exactly what the load will be, and it is, therefore, of the utmost importance to secure a drive which permits overloading or underloading without serious change from economy.

Old types of simple counterflow engines, the old reliable standbys of rolling mill service for over 50 yr., cannot be considered here. It is so wasteful that its low price is more than offset by increased cost of boiler-house equipment, not to mention the continuous cost of fuel and water. It retained its place in the mill a long time by reason of its simplicity; it was replaced here and

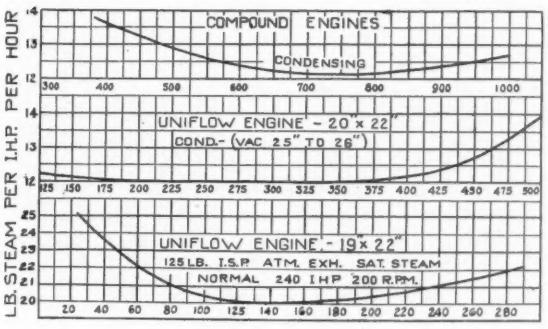

LB. STEAM PER I.H.P. PER HOUR
COMPOUND ENGINES
CONDENSING
UNIFLOW ENGINE - 20 x 22"
COND.- (VAC 25" TO 26")
UNIFLOW ENGINE - 19 x 22"
125 LB. I.S.P. ATM. EXH. SAT. STEAM
NORMAL 240 I.H.P. 200 R.P.M.

FIG. 1. WATER RATE LOAD CURVE OF A WELL KNOWN COMPOUND ENGINE

FIG. 2. WATER RATE LOAD CURVE OF A 20 BY 22-IN. UNIFLOW ENGINE

FIG. 3. STEAM CONSUMPTION OF A 19 BY 22-IN. UNIFLOW ENGINE OPERATING AT 125 LB. PRESSURE AND ATMOSPHERIC EXHAUST

there by the compound engine on account of its wastefulness. The uniflow engine combines the simplicity and overload capacity of the simple engine with the economy of the compound; it has the added advantage that its overload capacity is even greater than that of the simple engine and that its economy is sustained over a greater range of load. Finally, it has few moving parts and takes up much less floor space than the compound engine.

Prof. Trinks states that according to experience a uniflow engine with direct-current generator costs less than a geared steam turbine with generator. From this it may be concluded that an engine without generator, direct-connected to the mill, will cost less than a turbine plus generator, plus switchboard, plus motor, plus gear drive.

In the reduction of internal cylinder condensation lies the principal secret of the economy of the uniflow engine. The second reason for the economy of the uniflow engine lies in the enforced or compulsory tightness. Steam cannot leak from the live steam space to the exhaust.

The poppet valve is the only satisfactory form of admission valve, and while the valve gear may vary

considerably in its form, for poppet valve engines, and particularly uniflow engines on account of its larger expansion, above 500 hp. the lay-shaft drive is preferable.

Self-supporting pistons guided at the crank end only appear to be perfectly satisfactory only for the smaller sizes; in larger sizes this same design leads to a great deal of trouble. On account of difference in expansion the piston must be a loose fit in the cylinder, and this allowance, which varies over the length of the piston, is of utmost importance. The guiding of the piston by the crosshead is imperfect; the piston, therefore, wabbles around in the cylinder, riding now on one spot, then on another, never wearing itself in, but rapidly wearing itself out. In large engines of German design, a tail-

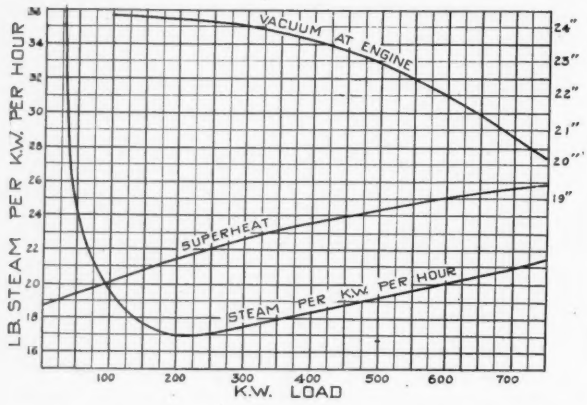


FIG. 4. CURVES MADE IN AN ACTUAL TEST OF A LARGE UNIFLOW ENGINE

rod guide has been provided, not so much for the purpose of carrying the piston, but mainly for the purpose of guiding it so that it will always touch the cylinder in a large surface. American engineers have gone one step farther and have made the piston rod, including the tail-rod, strong enough to carry the piston, in other words, actually to secure a floating piston.

In the early days practical development was thorny, cracked cylinders, heads, and bedplates caused trouble, also valve-gear troubles and regulation troubles had to be overcome, pistons and cylinders wore too rapidly; but the problems have practically all been solved, and the future promises to be free from any obstacles whatever. It can safely be said that the uniflow engine today is as reliable, if not more so, as the simplest engine of the counterflow type.

Figures 3 and 4 show the steam consumption of various types and sizes of uniflow engines.

The results in Fig. 3 were obtained from a 19 by 22-in. engine operating on saturated steam at 125 lb. pressure and atmospheric exhaust, its normal rating is 240 i.hp., and the speed is 200 r.p.m.

Figure 4 was made up from actual test results obtained from larger uniflow engines.

One of the largest uniflow engines on record, having a maximum continuous capacity of 6300 hp. and a short duration peak-load capacity of 8000 hp. is installed at the Rochlingschen Steel & Iron Works at Volkingen, Germany. The average load is 4000 hp. This engine is a 76 by 55½-in. unit, 120 r.p.m. It was built by Erhardt & Sehmer, operating at 130 lb. pressure, superheat of 169 deg. F., and drives a 30-in. three-high mill. A similar engine of the uniflow type of 1600 to 2400 hp. capacity, 43 by 51 in., running at 120 r.p.m., is installed at the Rombacher Iron & Steel Works, Germany.

One of the largest uniflow engines on record in this country is of the Nordberg type, installed at the Youngstown Sheet & Tube Co., Youngstown, Ohio. In fact, there are two, the larger driving a 12-in. rod mill, the smaller a 9-in. rod mill.

The larger engine is 44 by 50 in., 110 r.p.m., and has a capacity from 700 to 3000 and 4000 hp. The weight, including a 110,000 lb., 10-ft. wheel, is 480,000 lb. The smaller engine is a 37 by 48-in., 110-r.p.m., and weight, including a 90,000-lb. flywheel, is 360,000 lb.

These engines, according to the purchaser, have proven to be highly satisfactory.

Use of the Bleeder Turbine in Industrial Plants

WHERE STEAM IS REQUIRED FOR HEATING OR FOR PROCESS WORK THE BLEEDER TURBINE MAY BE USED TO ADVANTAGE. BY J. L. MOORE

BLEEDER OR extraction turbines have been used in a limited way and in comparatively large sizes for some years past and at the present time are available in sizes as small as 100-kw.

In an industrial plant where steam is used for heating, cooking or other process work, a bleeder turbine will in many cases show a considerable saving in the coal bill.

It consists usually of a high-pressure non-condensing turbine expanding the steam from the initial pressure to somewhat near atmospheric pressure, usually 5 to 30 lb. gage, built on the same shaft with and exhausting into a low-pressure turbine which expands all or part of the steam from the receiver or bleeder pressure to the vacuum in the condenser. A blank diaphragm separates the non-condensing high pressure turbine (A) in Fig. 1 from the low pressure turbine (B). Between the high pressure non-condensing turbine and the low pressure turbine the bleeder connection is made and steam is extracted.

Pressure in the bleeder connection is maintained constant or nearly so, by an automatic cylindrical valve actuated by any slight change of bleeder pressure. The automatic valve referred to controls the flow of steam from the receiver chamber (A) to the low pressure turbine (B). This idea is not new, having been used many years ago in connection with compound engines in New England textile mills. In this case the pressure in the compound engine receiver acted directly on a piston or diaphragm which controlled the flow of steam to the low pressure cylinder by varying the cutoff, by this means increasing or decreasing the amount of steam allowed to pass to the low pressure cylinder.

Turbines of this type may be designed for extracting steam at two or more different pressures if desired, for instance in plants where steam for a certain process

is required at say 60 lb. gage and for another process, or for heating the building at 5 lb. pressure. Two automatic bleeder valves would be required in such a case to maintain the desired pressures, the excess steam passing through the remaining stages to the condenser. If, in such a case, the excess steam is a small amount, it may be exhausted to the atmosphere, and low pressure stages and condenser dispensed with. Typical

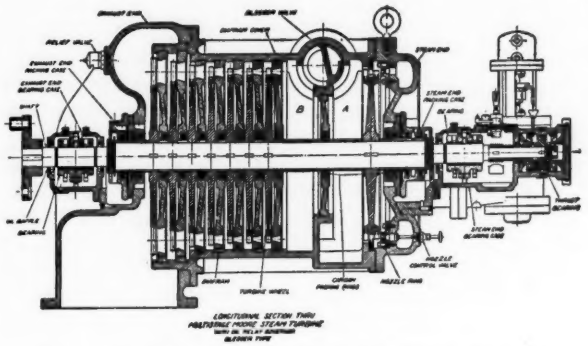


FIG. 1. CROSS SECTION THROUGH A TYPICAL BLEEDER TURBINE

"Bleeder" curves are shown in Fig. 3 which gives water rate with turbine operating either straight condensing or "bleeding."

Each Installation Should Be Studied

Each prospective bleeder installation should be studied carefully and the turbine designed to meet the exact conditions of the operation. The design of a "bleeder" turbine is a very flexible proposition, as it can be designed as a straight high pressure condensing turbine and at the same time any amount of steam

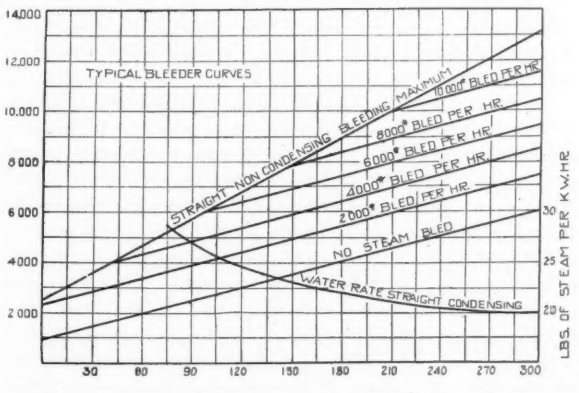


FIG. 2. TYPICAL CURVES SHOWING STEAM CONSUMPTION OF TURBINE

within reasonable limits can be bled by the use of extra nozzles on the first stage under the control of hand valves, or by a group of extra nozzles under the control of a single automatic overload valve. Hand valve control of the extra nozzles is satisfactory if the steam bled is practically constant. If it varies considerably and at frequent or irregular intervals, then an automatic overload valve is necessary.

In most cases these turbines must operate at times as a high pressure condensing turbine—bleeding no steam—and the design must be such that the best possible economy, when so operating, is obtained. At the same time the design must permit bleeding the desired quantity of steam when needed.

Possible Arrangements for Bleeding

A good design of bleeder turbine is one in which the bleeder pressure happens to be the same as the normal pressure in the first stage of a turbine designed for normal operation as a high pressure condensing machine. Such a machine would be designed with nozzle areas suitable for operating condensing, bleeding no steam, with extra nozzle area in the first stage to bleed any

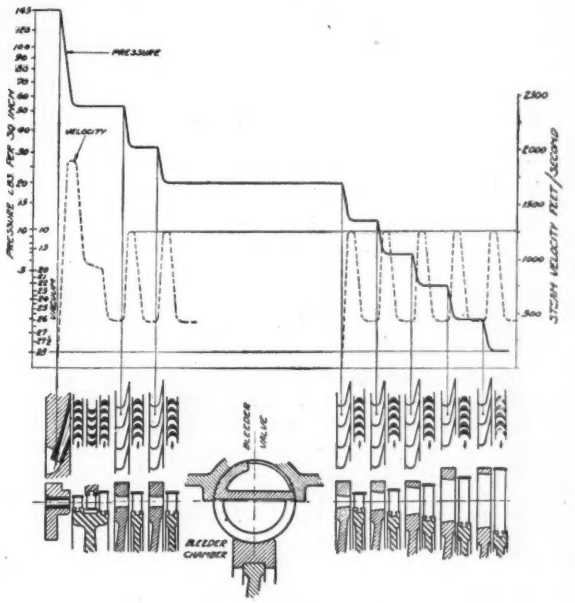


FIG. 3. BLEEDER VALVE PLACED AFTER SECOND RATEAU STAGE

required amount of steam up to the amount required to carry full load non-condensing; that is, exhausting all steam to the heating system, none going to the condenser. It is of interest to note that the bleeder pressure usually falls below the normal designed first stage pressure as mentioned above. For instance, assuming a steam pressure of 150 lb. at the throttle and 28-in. vacuum, the pressure in the first stage of a condensing turbine (the first stage consisting of a two-row velocity stage wheel) will be about 30 lb. gage. If it is desired, instead of bleeding steam at 30 lb., to bleed say at 5 lb. gage and at the same time retain the maximum efficiency of the high pressure condensing design, this may be done by placing the bleeder valve at a lower stage of the expansion which shows it following the second Rateau stage, the steam having passed through a two row velocity stage and two Rateau stages. Reasonable quantities of steam can be bled from a turbine of this design, although the design is not as flexible as in the design where the steam is bled directly following the first stage wheel. To take care of a variation of steam bled, extra nozzles are provided on the first stage, controlled automatically or by hand as conditions of operation may demand. An alternate method to meet the foregoing conditions would be to use a

three-row velocity stage instead of the two-row wheel with Rateau stages.

It may be said that the successful application of bleeder turbines depends, to a large extent, upon the careful study of the conditions in the industrial plant, by the manufacturer, and in designing the turbine to meet, as nearly as possible, those conditions. The proper selection and installation of bleeder turbines in many

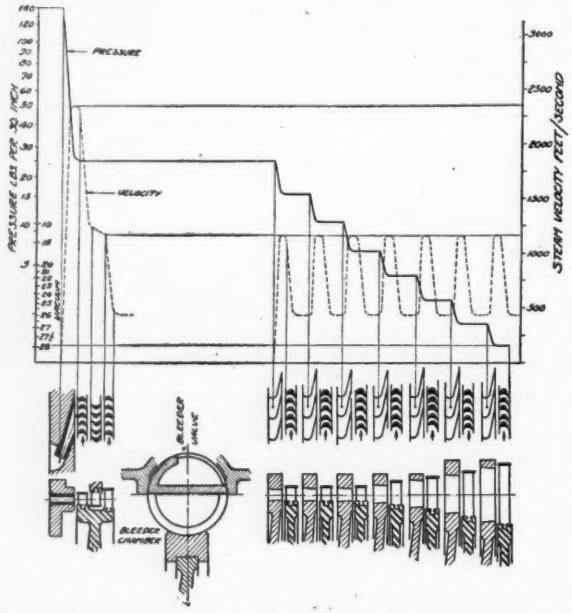


FIG. 4. BLEEDER VALVE PLACED AFTER THE VELOCITY OR CURTIS STAGE

of our industries having use for steam for heating or process purposes will show great savings over the present method of operation, where boiler pressure steam is passed through an ordinary reducing valve with entire loss of energy due to the pressure and heat drop.

Effect of Oiling on Diesel Engine Operation

OIL OF PROPER VISCOSITY IMPORTANT BECAUSE OF HIGH TEMPERATURES INVOLVED. BY M. S. HOWARD

CORRECT lubrication of the cylinders and the air compressor of a Diesel engine should not be a difficult matter. Nevertheless there is no doubt that the oil engine operator is frequently worried over carbon deposits and other ills directly traceable to imperfect lubrication.

As the bearings, both crankpin and main journal bearings, do not give any great amount of trouble, almost any oiling system, splash, ring oiling, stream feed or pressure feed, will keep these bearings fully supplied with oil. About the only time a bearing heats up for lack of oil is when carbonized oil inside of the piston drops down and gets into the oiling system. This carbon is the result of oil from the piston pin splashing upon the inside of the piston crown. The cast iron is quite hot and this oil chars or carbonizes and is shaken loose by the motion of the piston.

It is necessary, then, to devise means of filtering the oil in the bearing oiling system to eliminate the carbon. Most of the carbon can be eliminated by filtering through terry cloth, but there is a percentage of very fine carbon that passes through any filtering cloth. To remove this carbon, the oil should be washed with water which, after settling for 24 hr., will cause the carbon to settle to the bottom. The addition of caustic soda to the oil followed by boiling the oil will hasten the settling of the carbon particles.

REMOVAL OF WATER FROM OIL

OCCASIONALLY, in large engines where the pistons are water-cooled, water leaks at the trombone or knuckle joints. This water will mix with the oil and the agitation as the mixture passes through the oiling system will cause the oil and water to form an emulsion. This emulsion is, in fact, made up of particles of carbon or dirt about which is a drop of oil surrounded by a thin film of water; the drops assuming a spherical shape by reason of the film tension of the water. Such an emulsion will clog up the oiling system, form sludge, and destroy the oil film on the bearings.

It is absolutely necessary to break up this mixture, which is only possible by heating the oil to a temperature high enough to cause the water to change into steam and disappear. The carbon and dirt will, in the main, settle in the bottom of the treating tank. This treatment restores the lubricating qualities of the oil, with no change other than a slightly deeper color, due, no doubt, to colloidal carbon in suspension. At times there is an increase in the acidity of the oil, but this will not hurt the oil or bearing. The heating may be done by steam coils or by electric resistance coils inserted in a settling tank.

FILTERS ARE FREQUENTLY USED

OF LATE years the centrifugal filter has come into general use. This is in all respects the same as the ordinary cream separator. It may be connected up to the circulating system and the oil filtered continuously.

Fortunately the lubricating of the bearings is visible and any defect is easily discovered. On the other hand, the lubricating of the pistons and cylinders is done entirely out of sight and the results secured from the oil can be determined only by shutting down and inspecting the working parts. That the piston and cylinder must be properly lubricated, needs no argument.

It is agreed by all that the oil should be deposited on the cylinder walls at several points rather than at a single point. Even if the oil is fed at a number of points it must be distributed over the entire working surface of the piston. This is assisted to some extent by the action of the piston rings; but on all save the smallest of pistons, a groove about the barrel of the piston will insure an oil supply at all points.

In addition, there is an advantage in having the oil delivered to the piston at a definite point in the piston stroke. This calls for a timed mechanical oil pump and is the usual arrangement on modern high grade engines. There seems to be considerable amount of mistaken ideas concerning what takes place in the cylinder as regards the lubricating oils. Some, realizing the high temperature in the cylinder during combustion, do not understand how any lubricating oil can remain on the cylinder walls, and so wonder that lubrication is possible at all.

Others seem to think lubrication is a simple matter. Both ideas are wrong.

In the first place, from the time of ignition until the exhaust valve opening the temperature of the hot gases is far above the burning temperature of the lubricating oil; the result is that there is absolutely no chance for the oil to withstand this heat. It will evaporate and leave the cylinder walls dry. Even on the exhaust stroke the temperature is high but as the piston is, during this time, advancing toward the cylinder head the wall is protected from the heat. If the lubrication is deposited onto the cylinder wall and piston during this stroke, it will not be burnt off and the movement of the piston will smear a coat of oil over the entire cylinder wall. This film is uncovered during the suction stroke but at this time the cylinder temperature is low; no evaporation takes place.

On the next stroke, the compression stroke, there must be a film already on the walls if wear is to be avoided. It is therefore evident that the oil must be put into the cylinder during the exhaust stroke.

Oil Should Have Proper Viscosity

If the oil is too light-bodied it may flow too readily and so not stay on the walls. This means poor lubrication. If the oil is heavy-bodied the film will be thick and as the hot gases evaporate the oil on the surface, the oil next to the cylinder wall will not be burned fast enough. This oil will "crack," causing a coat of carbon or gum to stick upon the iron walls. On the next oil feed the coat will be made thicker. Finally this coat of gum will cause the piston to stick or "freeze."

From this it can be seen that the engineer must choose an oil which burns cleanly, yet has enough body to stay on the walls. If the engine is badly worn it may prove necessary to use a heavy-bodied oil to seal the piston clearance and this oil will probably cause heavy carbon deposits. Since a lighter oil will not form enough of a film the carbon and gum must be endured until a new piston can be secured.

In two-cycle engines where every other stroke is a power stroke, the lubricating problem is a serious one. The oil must be put on the piston at the end of the working stroke and at a point protected from the hot cylinder gas, but high enough up on the piston to allow the piston to deposit it onto the entire cylinder wall. It will be found that a fairly heavy-bodied or viscous oil must be used.

To secure good operation the piston rings must act as brushes to pick up the oil drops and smear the oil onto the walls. For this reason the top edge of the ring should be square to act as a dam while the lower edge should be rounded in order to enable the ring to pass over the oil film on the down stroke without causing the oil to pile up below the ring and so break up the oil film.

If the engineer finds that the oil he is using is causing carbon he should first reduce the number of drops fed. If the carbonizing continues an oil of a lower viscosity should be tried out. As a general rule in engines of 75 hp. and higher per cylinder a feed of 10 drops of oil per cylinder per minute is about correct. A viscosity of 200 to 300 Saybolt will, in most cases, cover the desirable grade of oil.

Steaming Value of Coke, Anthracite and Bituminous

Some interesting experiments have recently been conducted by the Bureau of Mines, on the value of coke, anthracite and bituminous for generating steam in low pressure boilers. These tests are described in technical paper 303, just issued.

Tests described in this paper were made to determine the relative steaming values of coke, anthracite, and bituminous coal when burned in a low-pressure boiler, and fired by hand in fairly large quantities at a time. A secondary purpose of the tests was to separate the heat losses, and to examine them carefully to determine the change in efficiency with the method of firing the fuel and manipulation of the draft dampers, with the rate of evaporation, and with the various fuels burned. Other purposes were the determination of the draft used, temperatures and composition of the gases in the flues, furnace, and combustion chamber, and other factors affecting the operation of the boiler.

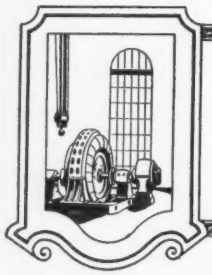
Before these tests were completed, some special tests were run at the request of the Chamber of Commerce of Pittsburgh, to compare the steaming value and smoke emission of mixtures of coke breeze and Pittsburgh coal with those of the latter alone; results of these tests are also embodied in this report.

Tests were made at different rates of steaming with coke, anthracite, and bituminous coal. Two tests also were run with a mixture of equal weights of bituminous coal and fairly coarse coke breeze, and two more with a mixture of equal weights of bituminous coal and a finer coke breeze. The calorific value of the coke ranged from 10,700 to 11,900 B.t.u. per lb., of the anthracite from 11,700 to 13,300 B.t.u., of the bituminous coal from 12,900 to 13,900 B.t.u., and of the coke breeze-bituminous coal mixture from 11,200 to 11,800 B.t.u.

Although the mean steaming values of the coke, anthracite, and bituminous coals were about the same, at the low rate of steaming the coke and anthracite evaporated more water than the bituminous coal, and at the higher rates of steaming the bituminous coal evaporated more water than the coke or the anthracite. The steaming value of the mixture of the coarser coke breeze and bituminous coal was about 80 per cent of that of bituminous coal alone, whereas the mean steaming value of the mixture of finer coke breeze and bituminous coal was lower than that of the mixture of coarser coke breeze.

Correction Note

Attention has been called to some errors which appeared in the article entitled "Lubricating Feature Added to Homestead Quarter-Turn Valves" on page 1180 of the Dec. 1 issue. In the second line of the last paragraph in the first column, the word "removed" should be "renewed"; in the fifth line of this same paragraph, the word "surface" was omitted which should be the first word of the line; in the last line of the first paragraph in the second column, the word "down" should be changed to "out"; and the first word of the next paragraph should be "The" in place of "This".



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Motor Applications in the Lumber Industry

BECAUSE OF ITS LOWER COST OF POWER AND ABSENCE OF FIRE RISK THE ELECTRIC MOTOR IS RAPIDLY DISPLACING THE DONKEY STEAM ENGINE. BY GORDON FOX

ELECTRIC DRIVE may be applied in connection with three distinct phases of the woodworking industry; namely, at the logging camp, at the sawmill and at the planing mill or wood fabricating establishment. The principal application at the logging camp is the logging engine, which is a winch for bringing in the logs from the woods to the point of loading. At the sawmill, the logs and timbers are handled and transported between processes largely by conveyors, roller tables or chain transfers which may be motor driven. The head saws which cut up the log and the various trimming and sizing saws for cutting the timbers to desired dimensions may all be motor driven. At the planing mill and woodworking factory, a great variety of machines are installed for cutting, shaping and finishing processes. All of these machines may be driven by motors.

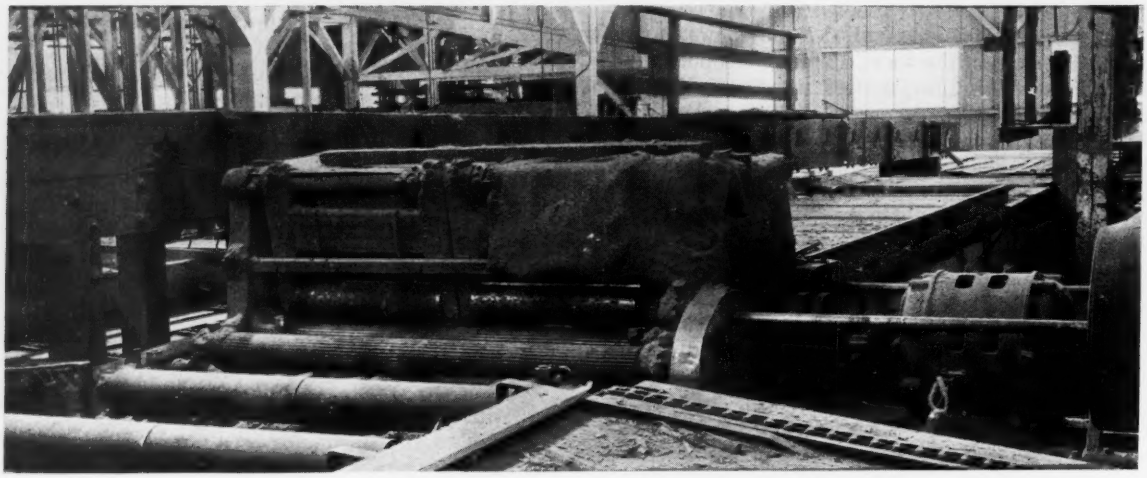


FIG. 1. PONY EDGER DRIVEN BY A 50-HP. INDUCTION MOTOR. NOTE ROLLER TABLES AND CHAIN TRANSFER, THE DRIVES FOR WHICH ARE NOT SHOWN

LUMBERING AND SAWMILLS

THE PRINCIPAL advantages of the electric logging engine over its predecessor, the steam donkey engine, are absence of fire risk and lower cost of power. The wood consumed by the steam donkey must be of good quality to permit splitting and considerable labor is required for this task. Logging demands the simplest possible outfit. For this reason and because of transmission considerations alternating current induction motors are universally used. These are of the wound rotor type, preferably enclosed, and are geared to the winding drums. A solenoid brake is supplied for quick stopping and to prevent any overwind of cable. A very quick stop is essential when the log strikes an obstruction. To prevent overtaxing the cable on such occasions, inverse time limit overload relays are supplied. The motor is ordinarily loaded well below continuous capacity, but is called upon frequently to deliver its maximum torque. Torque, rather than horsepower, is here the governing consideration.

Electric drive is now quite generally employed in saw mills. It is no more expensive an installation than steam engine drive, which it is superseding. Probably its greatest advantage lies in the ability of motors to carry through high peak demands with little drop in speed. In sawing operations, it is particularly desirable that the speed be maintained in order to retain the effectiveness of the tool. Alternating current is preferable for sawmill work for several reasons, namely; because such power is more readily available, because the principal drives, the saws, are constant speed equipments; and because the induction motor is most simple and rugged, is able to handle high peaks and introduces a minimum fire risk. Sixty cycles is the best frequency as it permits of motor speeds best suited to

sawmill machinery. The most popular voltages are 440 and 550 v. Some large motors are involved but the transmission distances are short and mill conditions are not favorable for higher voltages. Sawmill loads are subject to rather wide fluctuation, peaks are inherent and cannot be eliminated nor equalized. The maximum demand is usually about 70 per cent of the connected load. The average load is about 70 per cent of the maximum demand and about 50 per cent of the connected load. The power factor of the load is usually about 70 per cent. If an isolated power plant is provided, the generators should have liberal field windings, generous exciter capacity should be installed and automatic voltage regulation provided.

Squirrel cage motors are used wherever possible because of their simplicity and ruggedness. Wound

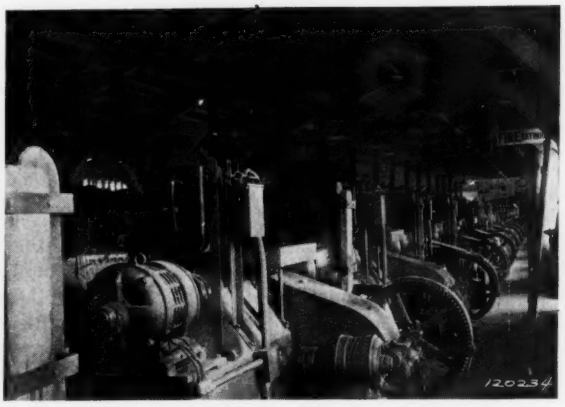


FIG. 2. SHINGLE MACHINES, EACH DRIVEN BY ONE 20-HP. AND ONE 3-HP. INDUCTION MOTOR

rotor motors are used where starting demands are severe or where it is desirable to relieve the system of high starting peaks. Open motors are commonly used but moisture proof varnish is sometimes specified for the windings. The collector rings of wound rotor motors should be protected.

Power requirements of the various machines vary for each individual installation, depending upon the size, length and kind of logs, the rate of cutting and the condition of the timber. Any figures given must therefore be very general in character.

Log Hoists

ENDLESS CHAIN types of log hoists may be driven by squirrel cage motors running continuously and provided with friction clutches or by wound rotor motors provided with drum controllers for starting and stopping. The cable type of log lift is gaining popularity due to its low maintenance. This equipment is in the nature of a winch and requires a wound rotor motor with holding brake and reversing drum controller. The motor is usually about 30 to 50 hp., depending upon the size of logs handled. Hoisting speed is about 40 ft. per min. The load is intermittent, the load factor less than 10 per cent.

Head Saws

LOGS ARE cut into timbers by means of the head saw, the log being held on a movable carriage and fed past the saw. Circular saws and band saws are both used for this work, the latter prevailing as it is more economical of timber. Circular saws start light. They are subject to wide variation in load, the peaks often reaching two to three times average demand. Squirrel cage motors are almost universal. Band saws have considerable inertia which, combined with the fraction drag due to saw tension, causes a heavy starting demand. Wound rotor motors are therefore commonly used, although squirrel cage motors with welded end rings may be used where the generating capacity permits the resultant high starting peak. The flywheel effect of the saw wheels is sufficient to equalize the load to some extent so that the peaks are less severe than those of the circular saw. If belt drive is used a fairly high speed motor may be employed. Head saws are large users of power, the motors commonly ranging from 200 to 350 hp. The load factor is about 20 to 25 per cent.

Log Carriage

ELECTRIC DRIVE can be provided to meet the requirements of the log carriage which handles the log driving cutting and requires rapid reversal and fast acceleration of comparatively heavy masses but steam engine drive is commonly employed. It is lower in first cost. The economy is not an important consideration, some steam is required for dry kilns and a boiler plant is therefore necessary.

For cutting the stock from the head saw to width the edger is used. It consists of several circular ripsaws mounted on arbors, the position being adjustable to govern the widths cut. A direct connected motor is well suited for driving the saws as motor speeds of 1200 or 1800 r.p.m. give the desired saw speed. The starting load of this machine is small but the running load fluctuates widely. Squirrel cage motors may well be used. They afford a well maintained speed, which is desirable. A motor of about 200 hp. capacity is common. The feed rolls of the edger must reverse and speed adjustment over a 2 to 1 range or more is required. A wound rotor motor is therefore utilized and secondary resistance control provided.

Trimmer

IT IS the function of the trimmer to cut the rough stock to length. It consists of a gang of circular crosscut saws spaced at 2-ft. intervals. These saws are belt driven from a main line shaft which, in turn, is driven by the motor. A squirrel cage induction motor of about 50 hp. capacity is commonly required. Most of the load is friction as the cutting load is very intermittent. Several saws may be cutting simultaneously. The load factor of this machine is about 60 per cent.

Resaw and Gang Saw

THIS MACHINE is used to re-cut stock to a lesser thickness than afforded in the original sawing. A band saw is used. The load characteristics are similar to those of a band head saw but the resaw is much smaller. A motor of about 75 hp. capacity is frequently used. Instead of using a wound rotor motor, a squirrel cage motor with high resistance rotor may be used, if the construction of the end rings is sufficiently substantial.

Gang saws are used to split a timber or cant from the head saw into a number of boards at one operation. These machines consist of a number of straight saws which have a combination of reciprocating and oscillatory motion. The load is cyclic in character and fluc-

tuates through the stroke of the saws. A flywheel is commonly used to equalize the load and a wound rotor motor or a squirrel cage motor with high resistance rotor is necessary in order to utilize the flywheel. A motor of about 75 hp. capacity is required.

Live Rolls and Chain Transfers

These are used to transport the stock between processes. Most of the load is friction, is therefore subject to variation from time to time and differs at various installations. For continuous operation in a single direction, squirrel cage motors are used. Group drive may be employed with clutches provided for the individual sections of drives. Where reversals are necessary the high resistance squirrel cage motor is generally preferred but the wound rotor motor is also used. Back geared motors are well adapted because of the low speeds demanded.

Electric Power Development in 1922

A Brief Review of the Outstanding Features of the Electrical Industry During the Past Year

ONE RESULT of the improvement in both industrial and financial conditions that took place during 1922 was the growing application of electric power, both to industrial and domestic use. As a natural consequence, not only was the demand for power generation and distribution apparatus increased, but stimulus was given both to the design of new and the improvement of existing forms of such apparatus.

Many new types of the smaller devices used in this service were developed, and many of the old ones improved, leading to the greater reliability and efficiency of the automatic station as a whole.

Generation

In line with the tendency to increase the size of individual generating units, the maximum rating for steam turbine generators was increased to 62,500 kv.a. In the field of Curtis turbines, however, the most notable features were the improvements in the design and construction of the turbines themselves. A long series of experiments culminated in the elimination of troubles with wheels and buckets due to vibration. Wheels are now built with a wide margin between operating speeds and critical vibration speeds, so that immunity from former difficulties and troubles is assured.

During the year new designs of turbines of 20,000 and 30,000 kw. capacity have been brought out. These machines are of the single flow design with a single exhaust and with special provision in the low pressure blading for passing large volumes of steam without going to excessive blade length.

Water wheel generators also increased in size, one for 65,000 kv.a. being built for the power development at Niagara Falls. Several large generators were also built for use abroad, among them two 25,000-kv.a., 6600-v., 50-cycle, 125-r.p.m. units for the Brazilian Hydro-Electric Co., and five horizontal shaft 22,222-kv.a., 11,000-v., 60-cycle, 300-r.p.m. units intended for a hydroelectric development on the island of Formosa.

Static Condensers for Power Factor Correction

Sturdy types of static condensers that may be classed with transformers and motors for ruggedness have been developed in power sizes for power factor correction. An entirely new conception of the condenser problem was followed, resulting in a condenser that needs no more considerate treatment than any other electrical apparatus in industrial plants.

Transformer Developments

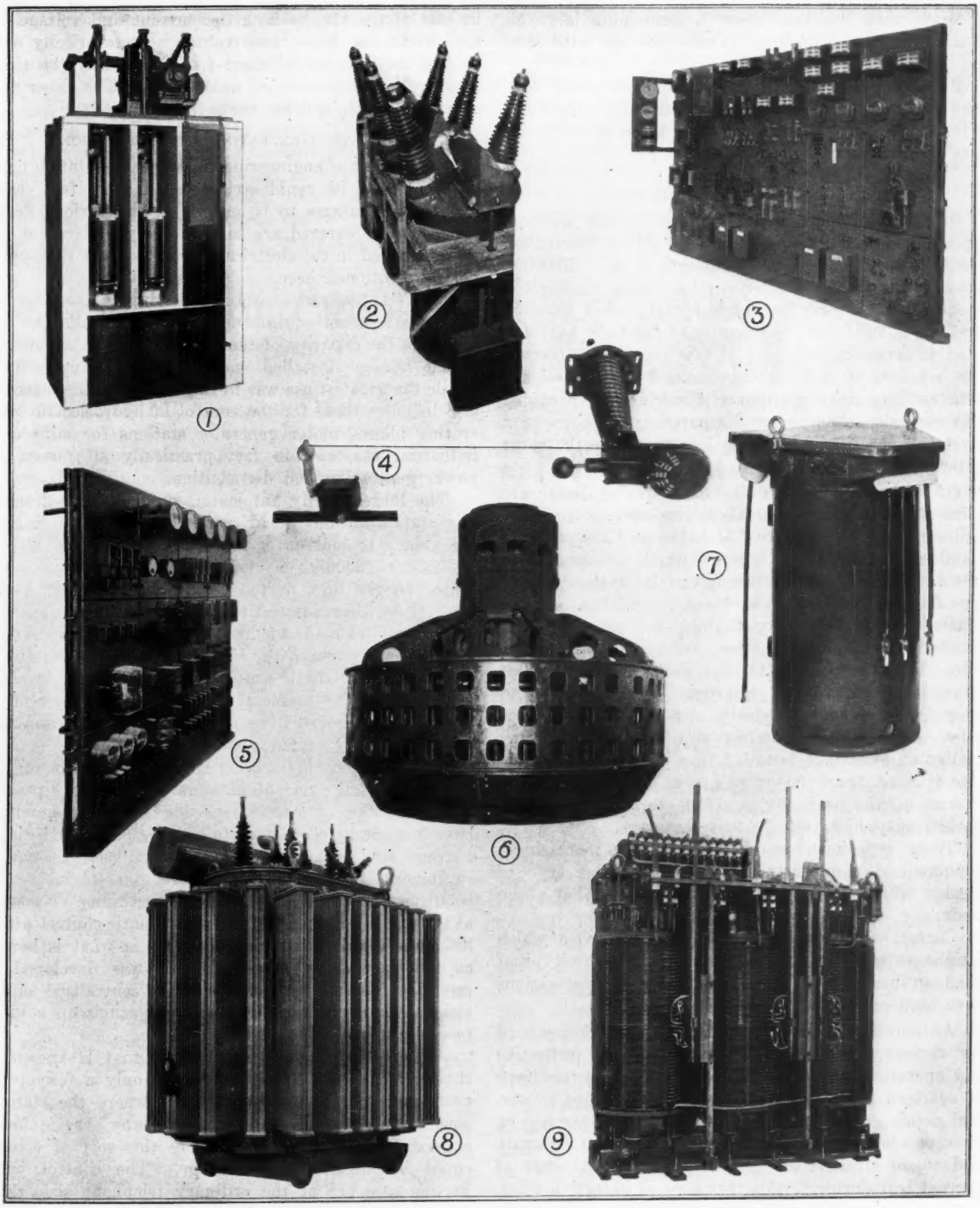
Renewed activities in hydroelectric development and the expansion of central station equipment in 1922 resulted in an unprecedented production in transformers of all classes. Among the large water-cooled types there were under construction seven 20,000-kv.a., 220,000/72,000-v., 50-cycle, single phase units which are larger in their physical dimensions than any transformers of this type previously built. Among autotransformers were 18 single-phase, 50-cycle units with an output capacity of 17,500 kv.a. each. Their normal rating is 5500 kv.a., 220,000 v. Y., or 200,000 v. Y./150,000 v. Y, being intended for inter-connection between the 150,000 and 220,000-v. lines of the Southern California Edison Co. They are designed for connection to the line without high tension switches or lightning arresters. All told there were a total of thirty-five 220,000 v. transformers under construction during 1922, as against eleven in 1921. This includes the output of all manufacturers.

A 1,000,000-v. testing equipment is being built for the California Institute of Technology. It comprises four 250-kv.a., 250,000-v. transformers. Four individual units are used in order to make the equipment more flexible for the wide variety of conditions which will be encountered in the laboratory.

Other large units that are notable are 10 water-cooled 22,000 kv.a., 68,000Y/12,000 v. transformers for use with the 65,000-kv.a. water-wheel generators at Niagara Falls, seven three-phase, water-cooled, 18,750-kv.a. 102,000/6600-v. units for the Wateree division of the Southern Power Co., and the largest self-cooled three-phase transformers ever constructed; two 12,000-kv.a., 44,000/13,600/2300/4000-v. units with a 50 per cent overload capacity for 2 hr. The average size of all types of the units produced in 1922 was about 1000 kv.a. greater than the average for 1921.

An interesting development was that of a new system for cooling large oil insulated transformers, especially in localities where water is scarce. This system comprises a battery of radiators installed either on the transformers or in a separate location, and in which the natural flow of oil between the transformer tank and the radiator is accelerated by low pressure air currents.

Other interesting devices are a new type of Venturi tube flow meter, with indicator for the water system of water cooled transformers, an oil drying and purifying outfit which utilizes the principle of a centrifugal separator, and an improved form of oil testing set. Also a complete line of welded steel tanks, of increased lightness has been developed for transformers of from 10 to 100 kv.a.



MILE POSTS WHICH MARK THE PROGRESS OF THE ELECTRICAL INDUSTRY DURING 1922

Fig. 1. 15,000-v., 500-amp. oil circuit breaker. Fig. 2. Largest 220,000-v. oil circuit breaker. Fig. 3. Automatic switchboard with duplicate manual equipment. This board is installed in the largest, fully automatic, single unit, hydroelectric station in the world. The station has equipment which controls a 2300-v., 5000 kw., 60-cycle waterwheel-driven generator. Fig. 4. High voltage definite time limit relay with impregnated paper cord connecting operating element to contact and time element. Fig. 5. Automatic control equipment for Kansas City Power and Light Co. This was an interesting application of the automatic principle. Because of the shifting load centers and the increase in load demand on the distribution system of the Kansas City Power and Light Co., extensions became necessary. Automatic control equipment successfully and economically solved the problem of operating substations having two or more incoming lines with two or more transformer banks, and the usual number of outgoing feeders. Fig. 6 31,250-kv.a. waterwheel-driven generator. This unit was furnished as an addition to an existing hydroelectric development, i.e., that of the Tallassee Power Co. The unit here shown is designed for mounting on top of an existing 18,000-kv.a., 36-cycle generator which is provided with a waterwheel of sufficient power to operate the larger machine. Fig. 7. All welded steel tank for distribution transformer. Fig. 8. 12,000-kv.a. 44,000Y/13,600//23,000/4000Y-kv.a. transformer viewed from low voltage side. Fig. 9. 12,000-kv.a. transformer viewed from high voltage side. The type of transformer shown in Figs. 8 and 9 are the largest self-cooled three-phase transformers ever constructed. They were provided with three windings for simultaneous operation, the 44,000-v. winding being designed for 12,000 kv.a., the 13,800-v. winding for 8000 kv.a., and the 4000-v. winding for 4000 kv.a. This gives them an equivalent kv.a. rating greater than any other self-cooled transformer ever constructed.

Much work has been done in developing large oil insulated force cooled transformers for use with electric locomotives.

Pressed metal tanks have proved so satisfactory with some lines of distribution transformers that their use is being extended as rapidly as possible to cover all lines of distribution transformers.

Switchboard and Distribution

One of the important developments in this line during the year was the perfection of a new line of oil circuit breakers, based on the design of the 220,000-v. breakers built for the Southern California Edison Co. The breakers of this line have round tanks, designed for 7500 to 220,000 v., the largest so far built having a rated interrupting capacity of 600 amp. at 220,000 v. The breakers of this line have round tanks, designed to be entirely tight, are non-oil throwing, are provided with explosion chambers and separating chambers, and have the operating mechanism located under the cover of the breaker.

Other developments in oil circuit breaker design are a line of motor operated breakers rendered oil tight and explosion proof by a system of baffles and a separating chamber that allows the gas generated on opening to pass outside the building through a pipe system; a new type designed for use on constant current transformer panels for series lighting to take the place of plug switches; and a line of large, cell-mounted motor-operated breakers adapted to the so-called isolated phase arrangement in central stations. The oil tanks of these breakers are electrically dead, and all breaker poles, disconnecting switches, and bus work for any particular phase are installed in a separate cell structure isolated from the other phases. Two schemes of separation, the horizontal and the vertical, have been worked out which embody these breakers.

Truck type switchboards have become increasingly popular and many new applications of this type of breaker which can be moved about as a unit have been made.

Carbon circuit breakers for marine service which can be supplied, when required, with a shock proof latch to meet the United States Navy specifications have been produced.

An enormous number of new relays were designed for various uses during the year, both for protective and operating purposes. The standard induction type of overload relay was improved and simplified in several details, and a new type was produced for use on circuits where the available tripping current is small, and where sensitiveness is desired, without the use of current transformers. Another type of induction relay, similar in appearance to a watthour meter, was developed to indicate when load conditions vary either way from a predetermined value. A three element induction type balanced current relay was designed to give differential protection to delta connected machines when differential protection cannot be obtained in the usual manner.

Another one of interest is a polarity directional relay which prevents reversal of circuits used to produce oxygen and hydrogen by the electrolytic process.

In the new line sectionalizing relay known as the impedance or distance relay, the element is acted upon, in case of trouble, by both the current and voltage of the circuit and from these values it automatically calculates the distance of short from relay and the time of operation is determined accordingly. The closer the short circuit, the quicker the action.

Automatic Generating and Substations

This phase of engineering in the central station field has continued its rapid strides of the past few years and the advantages to be gained in the various fields which can be covered are so thoroughly understood by those engaged in the electrical profession that they need not be mentioned here.

Important advances were made during the year in automatic control equipments, both as regards the increase in the capacity of the stations, and an expansion in the number installed and the field of application. While the greatest use was in railway work, the increase also includes those for the control of hydroelectric generating plants, motor generator stations for mine and industrial use, and in fact practically all phases of power generation and distribution.

The largest, fully automatic, single unit hydroelectric station in the world went into operation during the year. It consists of an equipment which controls a 5000-kw., 2300-v., 60-cycle water wheel driven generator on the lines of the New England Power Company. Another interesting application of automatic equipment was made to the existing alternating current distribution system of the Kansas City Power and Light Company. Automatic control successfully and economically solved the problem of extending the system to take care of the shifting of the load centers and the increase in load demand.

Two new developments have greatly aided in the expansion of the use of automatic control equipment. These are the automatic reclosing equipments, which have been designed to operate on alternating and direct current feeders. They not only protect the station equipment from possible damage due to abnormal conditions at the load, but insure continuity of service at the load. Another feature of automatic control which has been developed during the year is what is known as the supervisory systems. This was developed to meet the demand for some means of centralized supervision over a number of automatic stations on a large power system.

Of the Supervisory systems the first is known as the selector type. It is used where only a few operations per station are desired, and where the stations cover a large area. Interurban railway service forms a good example of a type where this sort of control could be applied to advantage. The control wires in this case are of the ordinary telephone size, three in number, and run continuously from station to station. Impulses of alternate uni-directional current are sent by code keys in the dispatcher's office to operate a particular selector in the outlying station, which in turn closes a local circuit and performs a specific operation. Auxiliary switches are mechanically closed when the operation is completed and this in turn causes the release of a particular code which on the local motor drives a sending key. This operates a selector in the dispatcher's office which in turn lights a red or green lamp, indicating at all times the electrical position of the apparatus in the outlying station.

The second system is the distributor type which finds use in power systems within a radius of 20 miles and where a large number of operations per station are required. Two cabinets, one in the dispatcher's office and one in the outlying station, have apparatus to control and indicate 50 circuit breakers. The distributors operate in synchronism and distribute either a positive or negative impulse, originating at a particular dispatcher's key to a certain two-position relay at the outlying station. This relay closes one of two local circuits, depending on whether it receives a positive or negative impulse, and this action performs the desired operation. Originating from an auxiliary switch on the controlled apparatus, an impulse is similarly sent back over a separate wire to operate a relay in the dispatcher's office and indicate the electrical position of the controlled apparatus. Four wires are required between each pair of distributors.

In concluding this article we wish to acknowledge our indebtedness to several of the larger manufacturers of electrical apparatus for data and information used in its preparation.

Work on Cahokia Station Under Way

NEW PLANT OF THE UNION ELECTRIC LIGHT AND POWER CO., WHICH WILL USE PULVERIZED COAL, EXPECTED TO BE READY FOR OPERATION BY OCTOBER

WORK on the 60,000-kw. section of the 240,000-kw. plant of the Union Electric Light and Power Co., St. Louis is progressing rapidly and it is expected that this section will be in operation by October. Several interesting features are involved in the design of this station, such as the use of pulverized coal for fuel, and the unusual foundation problem confronted because of the 45-ft. variation in water level of the river at this location.

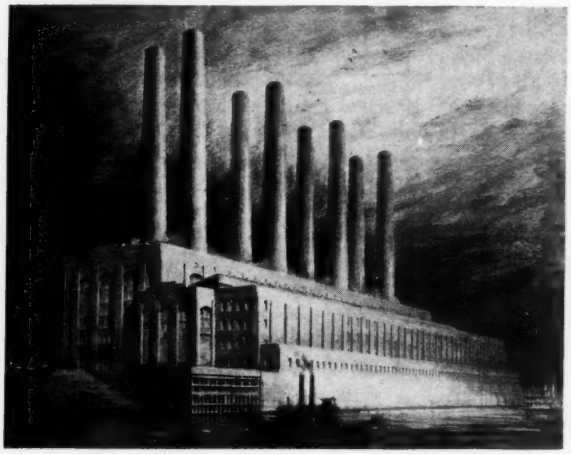


FIG. 1. ULTIMATE RATING OF CAHOKIA STATION WILL BE 240,000-KW.

On account of the nearness to the load center of St. Louis and the fact that railroad switching and bridge charges across the river could be eliminated, and also because of the accessibility of the Belleville coal district, it was decided to locate the plant on the Illinois side of the Mississippi River just south of the limits of East St. Louis. The site is located between the government levee and the river and consists of about 50 acres of low, flat river bottom ground which at the time of high water has been entirely flooded. From Fig. 1 showing the exterior of the ultimate station, and Fig. 2 showing a sectional view of the plant, it can be seen how this variation in water level has been taken care of.

In the design, the river wall is also the west wall of the station and is made up of precast interlocked concrete steel piles about 75 ft. long and weighing 15 T. each. To provide additional foundation support for the station, some 3000 concrete piles are being driven. The turbine room, electrical bay and river bay are to be supported on precast concrete piles, while the boiler room will be supported by standard Raymond concrete piles.

By building the river wall of the station on the inner harbor line, a long intake tunnel has been avoided and the intakes do not extend beyond the river wall. It will also be noted from the sectional view that the condensing equipment is placed in an elliptical pit, the floor of which is about 42 ft. below the turbine platform.

This new station has been made necessary by the growth of load in the St. Louis territory, and also because of the fact that the power supplied from Keokuk has been only about 60 per cent of normal because of low water. According to E. H. Tenney, chief engineer of power plants for the company, the present system peak is 125,000 kw. although the present rating of steam plants is only 122,000 kw. Normally, the Keokuk developments supply 45,000 kw. during peak load but for the past several months on account of the unusual low water conditions, 28,000 kw. has been about the maximum supplied. Considered from the standpoint of kilowatt-hours the power supplied from Keokuk has held up fairly well, so it is particularly from a standpoint of meeting peak load conditions and having sufficient reserve capacity that the new division is needed. For that reason, work is being rushed forward as rapidly as possible.

Normal operation of the station is expected to be at 200 per cent rating and 300 per cent rating operating for short peaks. The steam pressure will be 300 lb., 250 deg. superheat at the throttle. The turbogenerators will be rated at 30,000 kw. and energy will be generated at 13,800 v. three-phase, 60-cycle, and transmitted at this voltage, and at 30,000 v. through step-up transformers. The transmission will probably be by submarine and underground cables feeding into the existing lines of the company's St. Louis distribution system.

According to the design as laid out, the unit design of the station requires a minimum of immediate expenditure and will permit the company to take advantage of plant additions or changes with a minimum of effort or expense. This will therefore reduce the overhead charges

on the first operating section of the plant. As laid out, the building for the present station will occupy about 0.65 sq. ft. of ground per kw. and about 56 cu. ft. of space per kilowatt.

After an exhaustive series of experiments with various types of apparatus, McClellan and Junkersfeld, Inc., the engineers and constructors, it was decided to adopt pulverized coal for fuel, and while they state that this method is not applicable in every case, it was shown to be the most desirable method for this plant under the particular conditions of coal supply, the nature of the fuel and other operating conditions. The coal available is from the Belleville district with a relatively low calorific content and runs as high as 17 per cent ash. Combustion with pulverizing apparatus possesses the further advantage in its ability to burn low grade and mixed fuels such as might be encountered in times of coal shortage, strikes or other causes.

In the installation of the pulverizing equipment, a distinct feature will be the inclusion within the wall of the boiler room of all the preparation plant for the pulverized coal, thus occupying space in the boiler room not ordinarily put to such use. The pulverizing rooms are to be isolated from the plant proper by solid steel and heavy partition walls and are so arranged that the windows on the outer walls will relieve the pressure in the remote contingency of an explosion. Eight pulverized coal mills will be used for the eight boilers and when operating 16 hr. per day they will produce the coal needed for 24 hr. of boiler operation. Two spare mills are to be installed as a reserve.

When the coal is received, the railroad car will pass over a car dumper and the coal will be dumped into bins either from the car bottoms or by the use of a rotary car dumper. From the dumper the coal will pass over belts to a Bradford breaker of sufficient capacity for one-half of the ultimate capacity. After being crushed the coal is to be carried on belts to two vertical conveyors of the same capacity as the breaker and from this point it will be passed on to another conveyor where it will travel to the raw coal bunkers. These bunkers are to be located over head as will be noted in Fig. 2 and the raw coal will be delivered by gravity through a drier where it will be dried by passage of flue gases from the stacks. The coal will then pass to the pulverizing mills and from there to small fuel hoppers and will then be transported by a Quigley system which will include a blowing and weighing tank for each mill. From each tank a 4-in. pipe will lead to the pulverized coal bunkers, one of which is to be located in front of and above each boiler.

It is interesting to note that economizers are not to be installed in this station. According to the engineers, the present fuel conditions at this plant do not warrant the use of such equipment, although provision has been made in the plans so that they can be installed at a later date if the price of fuel should then justify such expense.

One other striking feature in the design lies in the large furnace space which will be used. This is considered necessary because of the high ash content and the long flame coal which is to be used. In the bottom of each furnace water screens will be provided to prevent slagging of the ash in the bottom of the furnace. Air used to cool the hopper bottom of the furnace will be mixed with the fuel at the feeders.

Two 2000-kw. house turbines will supply the energy to drive the auxiliaries, which will be electrically operated except for one boiler feed pump and one duplex exciter. The fuel feeder motors will be operated by direct current motors supplied by duplicate motor generator sets.

One feature of the electrical design is in the vertical isolated phase arrangement for busses and circuit breakers which will be used. A separate floor will be used for each phase but the main and reserve busses

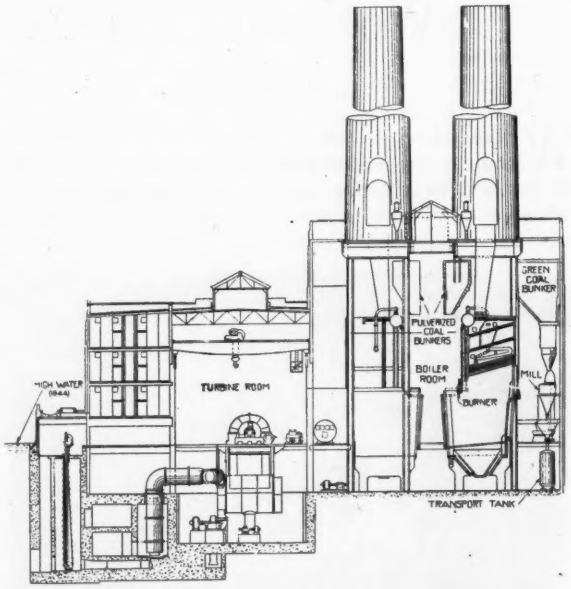


FIG. 2. AN UNUSUAL FOUNDATION PROBLEM HAD TO BE SOLVED BECAUSE OF THE 45-FT. FLOOD LEVEL

of the same phase will be on one floor, arranged, however, in separate rooms and further separated by an operating aisle. Truck type circuit breakers consisting of a single pole element for each phase will be suspended from the side walls of the breaker compartment. These oil circuit breakers will be operated by vertical rods from beneath. Disconnect switches will be remote manually operated and mechanically interlocked with the oil circuit breakers.

Control of the station is taken care of in two main control rooms. The main generator and feeder control will be on the level of the lowest phase floor of the switch house and the heat balance control room will be on a level with the turbo generator platform directly under the main switchboard control room. While these control rooms will permit of stopping the auxiliaries, they will not be arranged so that the auxiliaries can be again started, although in some cases such control as the speed of house turbines and certain motor driven pumps will be handled from these rooms. The watch engineer will have control of each of four boilers through apparatus located near the individual boilers in the group.

THE SMALL toad in a big puddle has plenty of room to grow, while the big toad in a small puddle has his limits prescribed.

Air Cooling by Mechanical Refrigeration*

REGULATION OF TEMPERATURE AND HUMIDITY MAY BE AFFECTED BY ARTIFICIALLY COOLED WATER. BY JEWELL B. WILLIAMS**

COOLING OF AIR by mechanical refrigeration is one of the latest applications of refrigeration to the industries and for the comfort of humanity.

All refrigerating engineers are familiar with the brine circulating system, where the brine is cooled in a tank or other cooler, located usually in the engine room close to the refrigerating machine, and then pumped to the refrigerators or rooms to be cooled. By circulation in pipes installed in the rooms this brine cools the air, after which it is returned to the tank to be recooled and used over again.

Instead of circulating cold brine, it has been found that in some cases it is better to cool the air at some central point and circulate the air instead of the brine. A blower is usually used and a supply of cool air can be fed to each room as desired. When more or less cooling effect is wanted in any room, the dampers in the air ducts are adjusted to meet the demand. The temperature of a room can be lowered more quickly with this system than with one in which brine or ammonia is circulated directly in the room to be cooled.

In this system the air is drawn, by means of a blower, from the rooms into an insulated bunker filled with cooling coils, and is then discharged by means of ducts to the various rooms to be cooled. The air is sometimes cooled to a temperature below that desired in the rooms so that as it rises to the room temperature, it will have the desired per cent of humidity.

In problems dealing with the cooling of air, the moisture contained in the air must be taken into account. This moisture or aqueous vapor is a form of steam. Atmospheric air is not usually saturated, that is, it does not contain all the moisture it is capable of holding, for that particular temperature. If, however, this temperature is cooled low enough, a saturation point or dew point will be reached and small beads of moisture will begin to condense on the cooling surface.

If all air were perfectly dry, the amount of refrigeration necessary to cool a given quantity would be small, but it is not and as the air is lowered in temperature, its capacity for holding moisture becomes less, consequently some of this moisture condenses or freezes on the cooling pipes. The cooling, condensing and freezing of this moisture will require more refrigeration than the cooling of the dry air.

Thus, to cool 1000 cu. ft. of air per minute from 90 deg. and 80 per cent relative humidity, to 40 deg. and 100 per cent humidity, will require a total for the air and moisture of 2172.05 B.t.u., while, if the air had been dry, only 909.2 would have been needed.

To arrive at the above results, the following factors were used.

Specific heat of air at constant pressure..0.2377
Specific heat of steam or vapor.....0.5000
Specific heat of moisture or water.....1.
Specific gravity of air.....0.0765
Latent heat of vaporization of moisture—
B.t.u. per lb. (approximate)..... 1000

To cool the dry air from 90 deg. to 40 deg. requires $1000 \times .0765 \times .2377 \times (90 - 40) = 909.2$ B.t.u. Air at 90 deg. and 80 per cent humidity contains 1.69 lb. of moisture per 1000 cu. ft. and the wet bulb temperature is 84.5 deg. To cool this vapor from 90 to 84.5 deg. requires $1.69 \times .5 \times (90 - 84.5) = 4.65$ B.t.u.

To cool the water from 84.5 to 40 deg. requires $1.69 \times 1 \times (84.5 - 40) = 75.2$ B.t.u.

Air at 40 deg. and 100 per cent humidity contains .407 lb. of moisture. The amount condensed is the difference, $1.69 - .407 = 1.183$ lb. To condense the vapor requires $1.183 \times 1000 = 1183$ B.t.u.

The total heat involved is the sum of these: $909.2 + 4.65 + 75.2 + 1183 = 2172.05$ B.t.u.

For good ventilation it is necessary to circulate enough fresh air to absorb the required air and still not contain over 0.06 to 0.08 per cent carbon dioxide. This forms the basis for calculating the necessary air circulation.

The human body is continually generating and throwing off heat at the rate of about 400 to 500 B.t.u. per hr. This heat, as well as that due to artificial lights, leaks through walls and openings must be taken care of, in the summer time, by means of mechanical refrigeration.

Unless the refrigeration problem is handled carefully, the room may be as uncomfortably cool as it was uncomfortably hot. Refrigerating engineers have found that the old standard of the heating engineers of 70 deg. temperature cannot be followed. To attempt to cool a public hall or room to 70 deg. on a day when the outside temperature is 95 deg., would not only be exceedingly expensive, but also far from comfortable or healthy. The lowering of the room temperature about 8 or 10 deg. gives one the feeling of comfort, especially if the air is sufficiently dry to permit free evaporation of perspiration.

Air for this service is usually passed through a washer and cooler located in the engine room or wherever space is available, and then distributed through ducts to the rooms to be cooled. Water for the air washer, having been sprayed into the path of the air absorbs heat from the air. This water collects in a sump under the spray, from which it is pumped through a tank equipped with coils of pipe in which cold brine or ammonia is circulated. After having been cooled the water is pumped under pressure to the spray nozzles and the cycle is repeated.

TO FILL a vacancy in the position of master electrician at the Navy Yard, Brooklyn, N. Y., an examination will be held throughout the United States on Jan. 24. The salary is $12.96 a day. The duties consist of the executive management and direction of an electrical shop employing about 300 men. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or secretary of the board of U. S. civil service examiners at the post office or customhouse in any city.

WE PAY no man more than he is worth.

* Abstract of a paper presented at the convention of the National Association of Practical Refrigerating Engineers in St. Louis, Nov. 1 to 4.

** Chief Engineer, The Triumph Ice Machine Co., Cincinnati, Ohio.

Foreign Developments Promise Higher Economy

AUSTRALIA EXPERIMENTS WITH LIGNITE; SPONTANEOUS COMBUSTION OF COAL ATTRIBUTED TO ONE CAUSE; TRANSFORMERS IN BANKS WORKED AT HIGHEST EFFICIENCY. BY J. H. BLAKEY

IN THE State of Victoria, Australia, are large quantities of lignite, known locally under the name of "brown coal." This can be mined at such a cost as to make it desirable as a combustible in competition with the coal from New South Wales, where the nearest

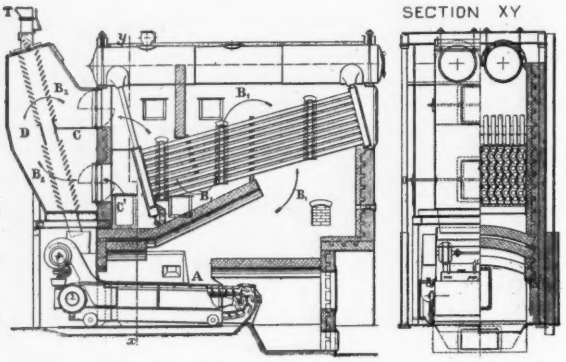


FIG. 1. BOILER BUILT FOR EXPERIMENTING WITH LIGNITE AS FUEL

coal fields are to be found. Consequently the Electrical Commission of the State of Victoria has directed Dr. W. A. Bone, of the Combustible Testing Laboratory of the Imperial College of Science and Technology, to conduct a series of experiments with a horizontal water-tube boiler (Fig. 1). This boiler was made according to the design of the Commission by The Underfeed Stoker Co., of London, England. It has a heating surface of about 2900 sq. ft. and a grate surface of about 110 sq. ft.

In front of the boiler is a large hopper, D, through the center of which the lignite is passed to the grate. Furnace gases are conducted first around the water tubes and then into the dehydrating compartment, where the lignite loses all of its moisture and about 88 per cent of its carbonic acid gas. It has been shown that by this means its value as a combustible is increased almost in the proportion of 1 to 3, and the amount of steam produced per sq. ft. of heating surface is increased in still greater proportion. Care has to be taken, however, that the temperature of the gases on entering the hopper does not exceed 750 deg. F., as a temperature higher than that is liable to cause premature ignition of the combustible. For the same reason the gases are brought first to the top of the hopper, although it would be desirable to reverse their direction.

SPONTANEOUS COMBUSTION OF COAL

IN THE Revue de l'Industrie Minerale of Aug. 1 is given the report of M. Thacker to the Association of Staffordshire and Warwickshire Engineers. A single cause of spontaneous combustion is now admitted, that is the spontaneous oxidation of the pyrites mixed with the coal; but the study of the influence of the pyrites is hindered by the fact that we are ignorant of the exact condition in which sulphate of iron is found in the interior of the coal.

It is recognized also that humidity facilitates spontaneous combustion; it seems to have here a catalytic action analogous to that which is produced in numerous chemical reactions. M. Lomax has shown that there is reason to believe in the existence of a product which he has called "globulite," a product formed of microscopic particles of carbon and pyrite, associated with derivatives of organic matters (fusain and cellulose). In the presence of moisture, this body would oxidize and give sulphuric acid, which in combination with ligneous fibers would give very lively reactions. Thus

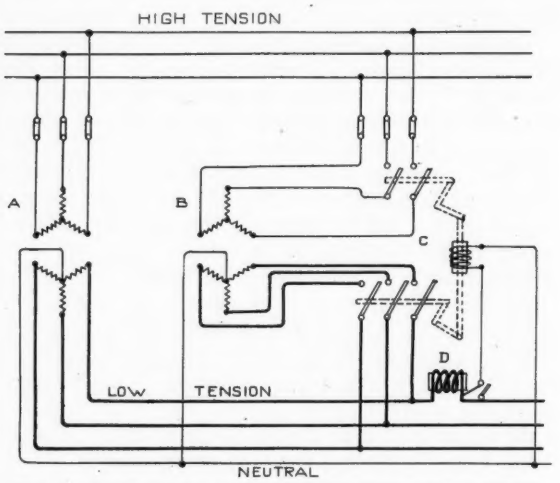


FIG. 2. DIAGRAM OF AUTOMATIC TRANSFORMER CUTOUT

might be explained the greater liability to spontaneous combustion of newly mined coal than of coal which has been subjected for some time to the action of the weather.

AN AUTOMATIC TRANSFORMER CUTOUT FOR SMALL STATIONS

MM. BRANDT and Fouilleret have devised a method of reducing power losses in transformer stations by automatically cutting out a transformer when the load drops below a given point. The principle is applicable especially in small stations at which there is no attendant but can also be used to advantage in large stations where a frequent recurrence of small losses may in time amount to a considerable total. The method of equipment is shown in Fig. 2. The transformer A is constantly in service; when the load exceeds a fixed value, the relay D closes the circuit of the contacts C, establishing the high and low tension circuits of the transformer B. The station is then in condition to furnish the capacity required. As soon as the intensity falls below the given value, the relay D falls and transformer B is automatically withdrawn from service. Study of the curve in Fig. 3 (registering ampere-meter with shunt of 200) shows that the values of the powers of the transformers A and B could be advantageously taken at 25 and 100 kv.a. respectively. Such a station may consist of any number of transformers. The

coupling in parallel of two appliances of sensibly different power may be done with perfect safety if certain precautions are taken.

M. Negre describes this arrangement in Le Genie Civil for Sept. 23, and gives a long calculation to show the losses in a 125-kv.a. station delivering a 220-v. three-phase current, the values of which are shown by the curve in Fig. 3. If the transformers are running at

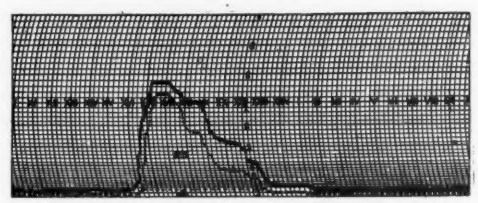


FIG. 3. CURVE OF CURRENT VALUES IN A 125-KV.A. TRANSFORMER STATION

an average of 0.96 of their capacity and the cost of electric energy is 8 cents per kw.-hr., with the transformers shown, the yearly loss would amount to 8644 kw.hr., or $692.

Heating with Condensing Water Reduces Cost

CHASE METAL WORKS PLANT, COVERING SOME 36 ACRES IS HEATED BY CONDENSER CIRCULATING WATER

TO DESIGN a heating system for a plant like the Chase Metal Works covering some 36 acres of land and containing thousands of square feet of glass surface, was the problem confronting the chief engineer, John H. Williams, when the plant was built. As the system is installed, this heating is effected by connecting over 78 mi. of pipe directly on to the condensers in the power house, and by pumping hot water through the mill, returning it to the condenser, re-heating it and then re-circulating it through the mill. One of these condensers supplies about 179,000 ft. of radiation, calling for 3000 gal. of circulating water per min., giving the mill a temperature of 56 deg. and the office 68 deg.

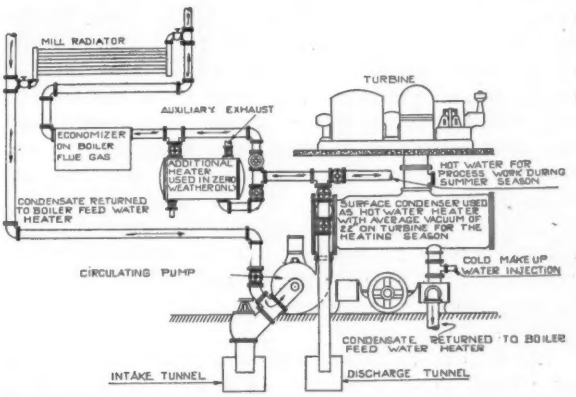
At the same time, a partial vacuum is maintained on the turbines and engines, irrespective of the heat requirements due to various temperatures in the hot water system. A diagram of the system is shown in the accompanying illustration.

There are five distinct heating systems in this plant; four of them can be connected into two systems during normal weather. All of them except the main office system derive their heat from exhaust steam, under a vacuum, taken directly from the pistons of the compound engines or blades of the steam turbines. These heaters receive the full heat of the steam at an average vacuum of 22 in. The water temperature is then "stepped up" by running the water through economizers. To derive all of the power possible from the steam, it is necessary, of course, to use the highest vacuum possible.

In this system, the main idea is that the turbines are connected directly on to the surface condenser and that the condenser is used as a heater for water for the mill, at the same time, the normal radiation of heat from the mill radiator pipes serves as a means of cooling the condenser circulating water. This eliminates cumbersome piping, valves and heater called for in running a vacuum system in connection with the turbine. It is also possible to maintain a full load on the apparatus, provided the power requirements are in excess of the heating, which is generally the case.

To provide for varying heating requirements, the condensate pump is able to handle a quantity of cold make-up water, to compensate for the variation in outside temperatures.

In zero weather, the condensate pump handles a full load, or, in other words, the circulating heating water is used over and over again. As the weather gets warmer, however, the right quantity of cold water is injected into the condensate pump and by being able to control the amount of cold water that is added, it is possible to maintain the proper temperature in the heat-


MILL RADIATOR
TURBINE
AUXILIARY EXHAUST
ECONOMIZER ON BOILER FLUE GAS
ADDITIONAL HEATER USED IN ZERO WEATHER ONLY
HOT WATER FOR PROCESS WORK DURING SUMMER SEASON
CONDENSATE RETURNED TO BOILER FEED WATER HEATER
SURFACE CONDENSER USED AS HOT WATER HEATER WITH AVERAGE VACUUM OF 22 ON TURBINE FOR THE HEATING SEASON
CIRCULATING PUMP
COLD MAKE UP WATER INJECTION
CONDENSATE RETURNED TO BOILER FEED WATER HEATER
INTAKE TUNNEL
DISCHARGE TUNNEL

SYSTEM ADOPTED BY THE CHASE METAL WORKS IN HEATING ITS BRASS MILL

ing system. This cold water is sent to the feed pump heater and thence to the boiler.

Two forced feed hot water systems are used and are connected to run either single or double as the weather calls for. The high pressure heating system covers 5¾ acres and the low pressure 12 acres, these two systems being run on the turbine only during normal weather.

In zero weather the steam requirements on the low pressure system takes the exhaust from the turbines under a load of 700 kw. while the high pressure system at this time receives its heat directly from the exhaust steam from the auxiliaries.

Seventy-eight mi. of pipe are connected directly onto the condenser in the power house, calling for 241,746 ft. of 1¼-in. pipe and 59,235 ft. of return pipe of from 1 in. to 8 in. in size. This makes a total of 300,981 ft. of pipe through which the water is constantly passing at a velocity of about 150 ft. per min., the work being done by steam and motor driven centrifugal pumps.

Three recording thermometers are used. The first gives the outdoor temperature. The second gives the temperature of returns. The water inlet is governed by outdoor temperature; 60 deg. temperature outdoors, for instance, calls for 120 deg. inlet temperature, zero weather would call for 190 deg. which gives the normal temperature called for in the mill. The weight of water circulated through the mill is recorded by flow meters.

Normally the heat return of a central station will not exceed 17 per cent, but the heat return from these condensers during the heating season has been over 70 per cent for the last ten years. Using condensers instead of indirect heaters attached to the turbines, taking the steam directly from those turbines and getting full value of the vacuum on the blades and also the full value of the heat from this vacuum, and then circulating the heating system water, or hot water needed for manufacturing directly through these condensers gives a heat return of 70 per cent and over.

Primitive Method Saves Delay

By Charles N. Shaw

TWENTY-ODD YEARS ago it was my fortune (or perhaps misfortune) to be sent from the shop to erect a boiler and engine which has been bought by my employer, overhauled and put in first-class condition. The boiler was a 60-in. by 18-ft. horizontal return tubular and the engine a 12 by 36-in. Corliss type of a well known make, and the outfit was sold by my employer to a man who had a large tract of timber to cut into lumber, much of which had already been sold and promised for delivery at a certain time, and the operation of the plant was promised at a certain time, a penalty being provided if this time was exceeded.

All the machinery was shipped and arrived at the railroad station in due time and was unloaded on the ground so as to save the demurrage charges. Previous to this, however, the foundations for the boiler and engine had been built.

As soon as the boiler arrived at the location, steps were taken to set it at once, so as to allow the setting to have as much time as possible to dry out before using; it was finished about two weeks before the expiration of the time, and a slow fire started. The engine was erected and was ready for the steam connection, and the piping started on the boiler in what was supposed to be ample time to get it finished and give us time to try out the plant. But, as usual, the unexpected happened, for on the Saturday morning before the Monday when we were supposed to start sawing, upon turning the steam into the engine supply, the riser between the throttle and elbow on the supply line was found to be split for a distance of 18 in. A new piece (4 in.) was at once phoned for, arrived on the 7 p. m. train and was brought to the plant. As it was dark and it would require only a short time to put the pipe in place, we decided to wait until Sunday morning so that we could have daylight to work by.

Immediately after breakfast we started to put in the pipe; but upon measuring it, it was found to be 11 in. too long; it had been ordered 9 ft. 10 in. and came 10 ft. 9 in. This plant was located 30 mi. from any shop and no trains running on Sunday, nothing but mules to make a 60-mi. trip, which was out of the question; automobiles were not as common as they are now. That piece of piping 11 in. too long must go in place before we could get the engine to turn over, and the next day we were supposed to start sawing lumber.

Language much more forcible than elegant was used by the owner of the mill when he was informed of the situation, and sharply informed me that if the mill was not sawing lumber Monday morning there would be h—— to pay; that didn't worry me much, but to keep him quiet I told him we would be all ready when the time came.

After he had ridden away I began to think the matter over and made up my mind that we would cut that piece of pipe and rethread it with the few tools we had.

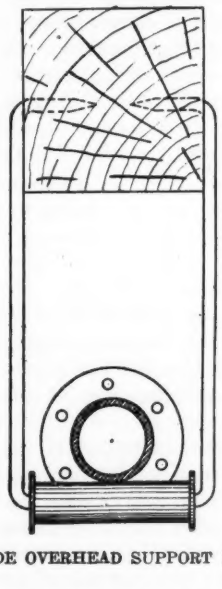
First I cut the pipe off to the right length by the "Armstrong method" (a hack saw). While this was being done, a 4-in. coupling that had been sent with the pipe in lieu of a thread protector, was screwed onto the original riser and was peened until it was swelled so that it would go up to the shoulder of the thread easily, on the piece that was being cut off. This short piece of pipe and the coupling was then screwed on the threaded end of the new riser. We were then ready to make the frame of the pipecutting machine, as we had a pretty good lead screw in the coupling.

Two horses, or benches, were then built, the cross member being of 4 by 6-in. with 2 by 6-in. legs, well braced. On the top of the cross members was placed a V block sawed from a piece of 4 by 6-in., well nailed to the horses; the pipe was then laid in the V blocks, the horses being so located as to allow plenty of working room at each end of the pipe, the end of the pipe having the coupling and short piece on it was then placed against one of the posts supporting the building, a piece of flat iron being placed between the pipe and post; the horses were then braced to the roof and a piece of 2 by 4-in. was placed over the pipe at each V block and fastened with lag screws to prevent the pipe from working out of the V blocks when the thread was being cut. A piece of 6 by 6-in. was then sunk in the ground at the end of the pipe where the thread was to be cut, and well braced. After this was done, we had a pretty crude pipe-cutting machine, all but the tool; for that I used a flat cold chisel, and with the "Armstrong" grindstone I fashioned a thread tool by relieving one corner of the cutting edge, and ground the point to fit the thread, fastened it in a groove cut in the end of the 6 by 6-in. block by a good stiff piece of wood over the tool held by lag screws, well drawn down, care being taken to locate the tool as near the center of the pipe as possible, being a little above the center if anything, and the point just beyond the end of the pipe to be cut. We were then ready to cut the thread, so by tapping the tool forward we started to unscrew the pipe from the coupling, which was held by one pair of tongs, the pipe being worked with the other. After getting about six turns on the pipe, we screwed the pipe back in the coupling, drove the tool forward a little and again unscrewed the pipe, making another cut on the thread. In about 2 hr. a very good thread was cut in this manner, and though without a taper, we put it up and turned on the steam. As only a drop of water showed at the joint, we let it go; in fact, that was all we could do. The engine was started and after running it for about 3 hr. and seeing that all was O. K., we shut it down and went to dinner (5:30 p. m.) tired, but satisfied that we had saved the day. Monday at 7:00 a. m. we were sawing logs, and as far as I know they are running yet. When I told my boss how I got out of the trouble, all he said was "huh," but when the next pay came I found an extra $2 and that was some raise in those days.

LETTERS DIRECT FROM THE PLANT

Hangers and Braces for Steam Piping

IN PUTTING up steam piping it should be so braced and suspended that it will be perfectly free to expand and contract with change of temperature and at the same time be prevented from vibrating. It must be so installed that the pipe will lie lightly in the hangers



EASILY MADE OVERHEAD SUPPORT FOR PIPING

and can come and go without having to move the hangers. Much of the trouble would be overcome if the right form of hanger were used. One of the best for steam pipe is the roller style and it is one that is easily made. If the engineer directing the installation would spend a little time in his office with pencil and paper, he would discover that he can easily design many different forms of roller hangers to suit almost any situation. About the simplest form of roller wall support is a long heavy log or wood screw with an iron washer at the head end and another at the back end of the screw with a short piece of iron pipe, having the ends carefully reamed out, between them.

A simple roller hanger is easily made. Sharpen the ends of an iron rod and slip over it a length of pipe somewhat longer than the diameter of the pipe to be supported. With this pipe located at the center, bend the rod through 90 deg. at either end of the pipe so as to form a U shape. Make two more right angle bends near the ends so that the ends point in. These ends can then be driven into the opposite sides of a wood joist as shown in the accompanying sketch.

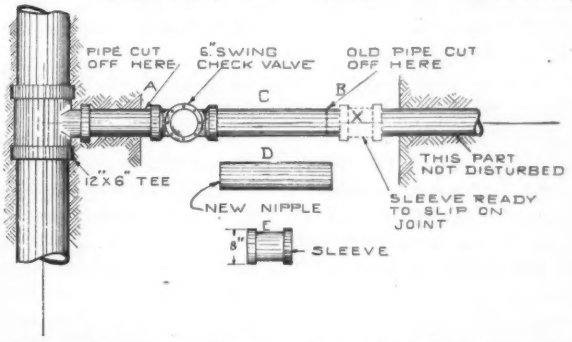
If the erector is experienced he will devote considerable time to the hangers, seeing that they are placed at equal distances apart between joints so that an equal weight will be thrown on each. Almost all long pipe lines require bracing at one or more points. These braces reduce the strain on the fittings but conditions should be carefully studied before deciding on the kind of brace to use and where to locate it. A heavy brace improperly placed may be a source of danger rather than a protection. Much of the trouble in steam lines is due to improper supports and poorly placed braces. Expansion and contraction, when not understood and provided for, is no more dangerous than poor hangers and braces.

JAMES E. NOBLE.

Underground Pipe Repair

THIS KINK on repairing an underground pipe line is offered to the readers of Power Plant Engineering in the hope that it will help someone to make good, some time in the future, as similar items have helped me in the past.

In a certain plant with which I am acquainted there is a fire pump having a 12-in. suction which runs about



EXCAVATION WAS NECESSARY ONLY AROUND THE DEFECTIVE VALVE

165 ft. underground to the well which furnishes the water. A few years ago it was found necessary to install a smaller pump to furnish water for certain processes in the works, and, to save expense, the suction pipe of the fire pump was tapped and a 12 by 6-in. tee set in about 15 ft. from the fire pump. The suction pipe for the service pump was led from this, about 40 ft. to the pump. To prevent trouble, a check valve was put into the 6-in. line about 4 ft. from the 12-in. line. This arrangement worked well until a few months ago, when, owing to several years of service, the check valve became badly worn and the fire pump began to get air in the suction. The check valve was dug up and found in such bad shape that it was necessary to replace it with a new one. It looked like a case of digging up 40 ft. of 6-in. bell and spigot pipe, taking it out and

making all the joints over again. That would have been some job.

Instead the 6-in. pipe was uncovered for a distance of about 8 ft. and was cut off close to the check-valve on the end nearest the 12-in. line. It was then cut off on the other side of the valve at a point about 2½ ft. beyond and the old valve and pipe removed. It was necessary to break in the old pipe to do this. The cuts are shown at A and B in the accompanying sketch. The new valve was then lowered into place and set onto the pipe, and a new piece of pipe (D) was cut to reach from the other end of the valve to within less than an inch of the pipe that had not been dug up; but before it was set in place to stay, a piece of larger pipe (8 in.) was slipped over the old piece of pipe at X. The valve and nipple were then set in place and the oakum and lead joints were made. Sleeve (H) was slipped back toward the valve until it lapped over (C) and (X) equally. Joints were run on each end and the line was ready for another 15 or 20 yr. service.

Time consumed was only about 12 hr. outside the digging up and recovering of the pipe, while, to have dug up the whole line and relaid it would have cost four times as much and would have taken all of two weeks with the help on hand. W. E. CHANDLER.

Aids to Burning Clinkering Coals

I HAVE BEEN having considerable trouble lately trying to burn low grade caking coal on a "V" type grate in a furnace which is provided with a combustion arch. Considerable combustible material is carried over with the clinker into the ash pit and it is necessary to clean the fire every hour or two. Some of the measures I have adopted have bettered the situation, but the results are not all that could be desired.

I have tried burning the coal as received, dry, and I have tried wetting it down thoroughly before firing, but there seems to be no difference in the results.

Operation of the plant is such that we have wood and other refuse available for burning. I tried mixing some of this refuse with the coal and got better results. The clinker breaks up more readily and does not stick to the grates as badly as it did. I have tried water in the ash pit and a steam jet; the former was of little avail, but the latter served to keep the clinker soft, although it is by no means an economical proposition.

W. J. MCKEEVER.

Regarding the Master Mechanic

TWO ARTICLES appearing in the columns of the Power Plant Engineering entitled "Working Under a Master Mechanic" are, to my way of thinking, rather humorous, or would be if there didn't seem to be an undercurrent of venom in them.

Why should an engineer, if he is all that the name engineer means, object to working under a master mechanic more than a superintendent, general manager, or other supervising head? Certainly every business must have a supervisory official, as long as the human element is as imperfect and untrustworthy as it is today.

True, there are many master mechanics who are not fitted to hold the positions they do, just as there are engineers unfitted to hold the positions they do; but as we find rogues in all branches of society and business, why condemn all for the shortcomings of a few?

In my thirty years' experience in handling machinery and men, I have several times had to be under the direction of a master mechanic, and sometimes it has been obnoxious; but I have been able to stand on my own legs and tell where I stood and where they got off, and never yet have I found that I lost my prestige by so doing.

Regarding the man who had never handled anything larger than 500 hp. running a 3000-hp. plant as well as a man who has handled 10,000 hp. and over, has to my way of thinking no bearing on the case whatever; for if a man is an engineer in all that the name implies, the size of the plant has nothing to do with the case in question. To be an engineer, one must keep abreast of the times by study and reading, and one plant is like another to one fit to be called an engineer.

Harm seldom comes from the engines, pumps, etc., of the plant; but the danger point lies in the steam generators if not properly taken care of, and a 75-hp. boiler can do as much damage when it gets ready to "go 'way from here" as one of greater size.

I want to tell of one case where the chief engineer of a large (16,000 hp.) station fell down.

To start with, it should be understood that the plant of which this chief was in charge was one of the best operated plants in the country and one that all engineers looked upon as a mark to shoot at, as far as the cost per kw.-hr. was concerned. At this time I was master mechanic of a large industrial plant, having nothing to do with the boilers or engines, except repairs, as directed by the chief of our plant, he and I talking over the repairs and deciding on what was best to do in all cases.

The engine plant consisted of seven high-speed 18 by 18-in. single, non-condensing engines, the exhaust being used for dyeing and drying, together with a small amount of live steam. Six of these engines were in use all the time, while the other was used as a standby to help out on the water wheel of one of the mills, in case of high or low water, the engine being connected to the water wheel jack shaft by means of a clutch, which was thrown in after the engine was started. By this means the shaft was brought up to speed when the water was not right to hold it so.

On the day in question I was away from the plant at a distant city inspecting some new machinery, and the chief engineer of our plant was away on a vacation, the different engines being in charge of men who were supposed to be engineers, but were in reality only oilers. When it became necessary to put on this spare engine, owing to low water, it would make only two or three turns and then stop. After trying several times to get started, and failing, the chief from the big power plant was called in to get the engine going; but the engine acted for him just as it did for the operating men. I was then called on the long distance phone and asked to come home as soon as possible. As about 8 hr. would elapse before I could get there, I asked what the trouble was. After it was explained to me by the office manager, I asked to have my assistant master mechanic put on the wire. He told me that he had not been notified of any trouble. I told him to go to the engine room, find just how the engine acted and report to me.

After making his inspection, he told me that the engine would make two turns and then stop. I asked him if he had noticed whether the exhaust valve in the connecting line to the exhaust main was open or not. He said he hadn't looked at anything except the engine, so I told him to go back and look at the valve and if it was shut to open it. Presently he returned and reported the engine running all O. K. after opening the valve except that it was leaking quite badly around the cylinder head. I surmised that the studs were strained and instructed him to place a man at the stop valve on the steam line to the engine (not the throttle) and in case the head showed any further signs of distress, to shut it down and put in new studs. The old studs held, however, until shutting down time, when new studs were put in, three of the old studs twisting off before the nuts came loose.

It was nothing against the big chief that he did not get the engine going; rather it was his strangeness to that particular plant, and his supposing that the valve had been opened, as it should have been before trying to start the engine. This, however, was one case where the master mechanic was just what his title says, master of the entire mechanical plant, including the engine room. CHARLES N. SHAW.

Locating Stay Rods in Brick Wall With Spirit Level

BULGING OF brick walls is a condition brought about more through vibration than through excess loads. It is noticeable that this is a condition in brick work, when adjacent to railway tunnels, tracks or trolley car lines. The passage of a train or car results in a noticeable shake which is transmitted to the floors and can be readily felt. The position of maximum bulge in the wall will occur at the place where the most excessive vibration occurs. Sometimes this is at the top or at the first or second floors. To correct this, it is the usual practice to put in stay rods, binding together opposite walls.

In a building where a local builder was called upon recently to install stay rods, he used a most simple means of detecting the place of maximum vibration. A steel case spirit level was held against the wall at the top, first and second floors, while passing trains set up the vibrations. The shape of the bubble from vibration was the determining test. When excessive vibration occurred the bubble went through a series of spasmodic changes in shape, extending and contracting. This is easily illustrated by placing a spirit level against any machine which is running with excess vibration, the vibration is transmitted into a bubble when the level is held solidly against the machine. The place of maximum vibration is indicated by the greatest distortion of the bubble. G. A. LUERS.

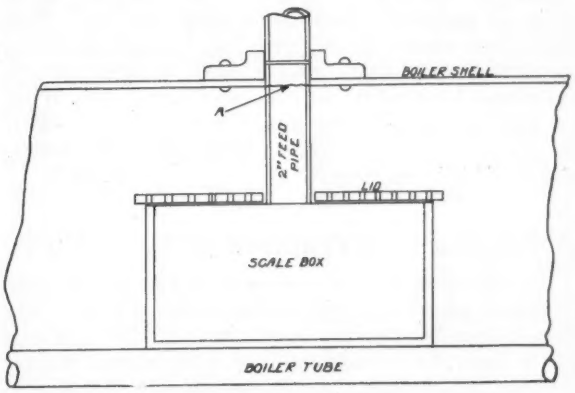
Leveling With a Hose Full of Water

IN REFERENCE to a recent article written about leveling with a hose full of water, I doubt if a man alone can handle it. The way I have used it is with a glass tube fitting snug in the hose and extending at least 6 in. above the hose, by fastening the hose near the ends with a string or wire to a block of wood about 6 by 6 in. the leveling can be done by a man alone; the difference in level can be measured from the level of the water in the glass. It is a very practical way to level long shafting in place even with different diameters and to go over bearing boxes, timbers or pipes that might be in the way. To make sure that there will be no air in the hose, fill it up by immersing it in a tub of water.

CHAS. LABBE.

Corroded Pipe Causes Rattling

A DISAGREEABLE rattling noise started in connection with a battery of five 100-hp. steam boilers in the plant where I am employed. Investigation placed it in connection with No. 3 boiler. The noise would begin as soon as steam pressure was raised and the feed valve opened. The method of feeding is shown in the sketch. On top of the scale box was a cast-iron lid with a number of holes in it. After several attempts to eliminate the trouble, by careful examination, a break in the feed pipe was found at A; the pipe was not broken off but



FEED PIPING TO BOILER

badly corroded, clear through the pipe in several places. As absolutely no noise occurred when water was being fed into the cold boiler, it is practically certain that it was the effect of the leaking water into the steam space which caused the disturbance. A new piece of pipe inside the boiler stopped the noise. JOHN THORN.

Obtaining the Pitch of Thread in a Tapped Hole

RECENTLY an incident in a local shop revealed an unusual but simple means of obtaining the pitch of the threads in a tapped hole for which it was desired to make a stud. While the mechanic assigned to the work was foraging around in the tool room searching for various pitches of taps with which to test the thread, the foreman, noting the delay and desirous to start the job, picked up a stick of wood, shaped it round with his pen knife and screwed it down into the tapped hole heavily enough to make the thread cut indentations on the surface.

With a thread gage the marks were measured and the pitch obtained. This was completed so rapidly that the mechanic was called off the search for taps, even before he had obtained two sizes. This is a simple and effective means of obtaining the requisite thread pitch.

L. A. GATES.

QUESTIONS AND ANSWERS

Methods of Cleaning Steam Condensers

I WOULD like to know the most effective methods of cleaning steam condensers which have been employed by readers of Power Plant Engineering, how long the condenser must be out of service, what devices are employed, frequency of cleaning, what effect such cleaning has on vacuum or circulating water required.

W. M. M.

When Is Safety Valve Too Large for Boiler?

"How WOULD you test a pop safety valve to determine whether or not it is too large?" was a question asked me in an engineers' examination some time ago. How should it be answered? Suppose that I should return to my plant and find that for some reason or other someone had changed the safety valve on one of the boilers. Without making any measurements, how could I find out if the new valve were too large? What will be the results of a test if it is too large?

P. O. M.

Ammonia Gas Trapped in Open Pipe

IN REPLACING some old valves of odd sizes in a direct expansion ammonia refrigerating system, I had to take down a long bend in the liquid line. I tried to give it a little sharper curvature and in so doing cracked it along the seam, which runs along the outside of the bend. At the time, the pipe was open at both ends and was being held in a vise. When the seam opened, I got a dose of gas. Under the circumstances, I don't understand how there could be any gas present. Can some reader offer an explanation?

R. G. S.

Loss Due to Combustible in Refuse

WILL YOU kindly give me the correct method of figuring the loss due to combustible in the refuse and demonstrate with an example showing the loss in percentage of the fuel fired?

J. W. L.

A. An equation given in Gebhardt's Steam Power Plant Engineering for heat lost in the refuse is

$$h_3 = h_c \div 100 \times (y \times a) \div (100 - y)$$

where h_c is the calorific value of the combustible in the dry refuse; y, the per cent combustible in the dry refuse; a, per cent ash in the coal as fired; h_3, the heat in fuel, B.t.u. per lb. of coal as fired.

The loss may be expressed as per cent of the heat content of the fuel by dividing both sides of equation by h_4, the heating value of the coal as fired and multiplying by 100. For ordinary purposes where extreme accuracy is not necessary h_c may be taken as equal to h_4.

Another somewhat different equation is given as

$$x = 100 \times a \times y \div [(100 - a)\ (100 - y)]$$

where x is the percentage of loss.

Assuming a coal having 10 per cent ash is so burned that the combustible in the dry refuse amounts to, say, 30 per cent, we have

$$100 \times h_3 \div h_4 = h_c \div h_4 \times y \times a \div (100 - y)$$
$$= 1 \times 30 \times 10 \div (100 - 30)$$
$$= 300 \div 70 = 4.28 \text{ per cent.}$$

or

$$x = 100 \times y \times a \div [(100 - a)\ (100 - y)]$$
$$= 3000 \times 10 \div [(100 - 10)\ (100 - 30)]$$
$$= 30{,}000 \div 90 \div 70 = 4.76 \text{ per cent.}$$

The difference in these two equations lies in the fact that in the first the heating value of the combustible in the refuse is assumed the same as that of the coal as fired, while in the second this value is assumed equal to the heating value of the *combustible* in the fuel as fired.

Boiler and Furnace Efficiency

WE RECENTLY obtained some figures on the performance of our boilers and I would like to know how they are to be interpreted:

Heating value of coal, B.t.u., per lb.	13,200
Evaporation from and at 212 deg. F., lb.	7
Temperature of flue gases, deg. F.	600
Temperature of saturated steam, deg. F.	325
Heat delivered to stack, per cent of heat of fuel fired	35

What is the combined overall efficiency, the true furnace efficiency and the true boiler efficiency?

P. E. F.

A. From the figures given, the heat absorbed by the boiler per pound of fuel fired

$$H_1 = 7 \times 970.4 = 6790 \text{ B.t.u.}$$

the overall boiler, furnace and grate efficiency based on the fuel as fired is then

$$E = 100 \times 6790 \div 13{,}200 = 51.5 \text{ per cent.}$$

As for determining the boiler efficiency and the furnace and grate efficiency separately, it is practically impossible unless an arbitrary line of demarcation between the two is established. There is, however, no general agreement on this subject.

Heat losses chargeable to the furnace and grate alone are the loss due to fuel dropping through the grates or withdrawn from the furnace including solid combustible in cinders, soot, flue dust, etc.; loss due to production of CO instead of CO_2; loss due to escape of unburned volatile hydrocarbons, and loss due to heating excess air to the steam temperature.

Boiler losses may be considered as loss due to the heating of the moisture in the fuel and air and that formed by the combustion of hydrogen from the steam temperature to the flue gas temperature; loss due to heating theoretical CO_2 and nitrogen from steam to flue gas temperature; loss due to heating excess air between these same temperatures.

Radiation and unaccounted for losses are divided between the boiler and furnace, but are practically inseparable.

There are other losses which may be considered as unavoidable and are in no sense chargeable either to the boiler or the furnace.

These are the loss due to heating the moisture in the coal, air, and that produced by the combustion of hydrogen to the steam temperature; and the loss due to heating the dry products of combustion with theoretical air supply to the steam temperature.

Maximum theoretical efficiency is then 100 minus the unavoidable losses divided by 100.

Furnace and grate efficiency based on heat available after deducting unavoidable losses is 100 minus unavoidable losses minus furnace losses divided by 100 minus unavoidable losses.

Boiler efficiency is 100 minus all losses divided by 100 minus unavoidable and furnace losses.

Overall efficiency is the product of the three efficiencies mentioned.

Elimination of Oil from Boiler Feed Water

I NOTE J. A. P.'s request for suggestions as to how to keep oil out of his boilers, which appears on page 1223 of the Dec. 15, 1922, issue of Power Plant Engineering. In reply, I offer the following:

First, the cause of the trouble is threefold:

1. Too much oil is used.
2. Provisions for catching the oil that goes out with the exhaust are inadequate.
3. Apparently a compounded oil is used which readily emulsifies with water, hence can but get into the boiler through the feed.

As a general thing, most operating engineers are prone to feed too much oil to engine cylinders, and the excess must of course go out in the exhaust steam. By experiment, it can be found just how little oil is actually required to effect correct lubrication, and also to maintain the necessary piston seal. Nothing whatever is gained by supplying more than is needed for the purposes specified. Of course, it is next to impossible to gage the quantity of oil to be fed to the cylinders so finely that none will get out with the exhaust; but the aim should be to reduce the quantity thus escaping to a minimum.

In order to take care of the oil that may come out with the exhaust steam, that is, to separate it from the steam and from the condensate so that it cannot get into the boilers, oil extractors and feed water filters should be installed in the lines. With well chosen apparatus, no oil will get into the boilers, especially where the right quantity only is fed to the cylinders, and care is given the extractor and filter.

Where the condensate is to be returned to the boiler for feed, a compounded cylinder oil should not be used. Compounded oils will form an emulsion with water, and that emulsion can only be broken up by allowing more time than can be given in the cycle of engine operations. Emulsified oil is difficult to handle even with the best apparatus. Because of this, use either a straight mineral cylinder oil, which will not easily emulsify, and thus make it easy for the oil extractors, and feed water filters to properly do their work.

In short, use less oil, by employing a controlled feed, as for example, a mechanical force feed lubricator. Use only a straight mineral high grade cylinder oil, which because of being high grade, less of it will be needed. Install an oil eliminator, and a feed water filter of approved design, and periodically clean them out and keep them in good working order at all times.

CHARLES J. MASON.

Water Hammer in Boiler Feed Line; Pop Safety Valve Operation

IN REFERENCE to Mr. Molloy's answer in the Dec. 1 issue, to W. S. S.'s question in the Nov. 15 issue, I do not think Mr. Molloy could have read this query aright, for W. S. S. plainly states that the supposed water hammer takes place only when the pump is speeded up. When a pump is run over a certain speed, the action of the pump becomes jerky to a certain extent (particularly if there is much slippage past the water piston). This jerky action causes a momentary break in the continuity of the flow of the column of water in the feed pipe. When this happens, the boiler check valve starts to close; but before it has time to close, the boiler pressure is transmitted back to the spring actuated discharge valves, which are already on the point of closing, and down they go with a bang that is heard all over the place.

As the only remedy for this condition, get a pump with a larger capacity, so that it will not have to be speeded up beyond the critical speed at which the water in the feed pipe will surge. The ideal condition of operation for a duplex feed pump is this. Both sides must travel at the same speed, and each side must have picked up to full speed by the time the other side is losing its speed. There is then a continuous forward movement of the water, and no slamming can possibly occur.

Allowing 34½ lb. of water per boiler horsepower, a 6 by 4 by 6-in. duplex pump running at 66 strokes per minute will supply about 600 boiler horsepower; but owing to slippage, and the fact that a man will sometimes let his water get low and consequently have to speed up the pump, this figure should be reduced 50 per cent. Therefore, if W. S. S.'s pump is in good condition and his boilers do not exceed 300 hp., a 6 by 4 by 6-in. pump should supply them without trouble.

My advice to W. S. S. is, "Take off the water end cylinder head, then caliper the liners, first at the ends and then in the middle. If you find the liners worn, replace them. Make sure the valves do not leak and that there is no leakage from chamber to chamber through bad gaskets, or sand holes in the casting. Then if the pump still slams, you may be fairly certain it is working beyond its capacity. R. A. WOODS.

ON PAGE 1224 of the Dec. 15 issue, Fritzie has a suggestion to offer to W. S. S. on his article in Nov. 15 issue. He advises tapping into the suction pipe near the pump with a 1½-in. line, and when the pump is speeded up so that it begins to hammer, then open up this cold water line until the hammer stops; he also says that the hammering is caused by steam binding in the pump.

Steam binding will cause the pump to race, and put a severe strain on the pump and fittings; but I can see no reason why there should be water hammer with it.

If you were going to open a valve so as to let cold water into the suction pipe every time that there was a

water hammer, it would require the attention of one man most of the time to open and close the valve.

On page 1177 of the Dec. 1 issue, P. J. Molloy states that the water hammer is, in his opinion, caused by cold water that enters the suction line, which is opposite to what Fritzie thinks.

If I had that trouble with water hammer, I would get a receiver if possible; but if that could not be had, I would enlarge the suction pipe. Water coming in through the 1½-in. suction pipe under the pressure near that of the atmosphere is not enough to fill the 1½-in. discharge pipe where there is pressure greater than the boiler pressure. If the pipe were changed to 2½ in., part of the trouble would be eliminated.

An air chamber on the end of the discharge pipe would also help. In one plant where I had charge for some time, there was about 4 ft. of 2-in. pipe on the end of the pipe.

Concerning the article on page 1124 of the Nov. 15 issue about safety valves that do not operate properly, a valve that blows back 10 to 30 lb., might not have been quite right when new. Possibly there are not enough holes beneath the huddling chamber, and the blow back would be great if this was the case. To remedy this trouble, holes can be drilled through the top of the huddling chamber.

First of all, I would take the valve apart and see if all these holes were clean, as sometimes they get plugged. It may be that adjusting the blow back ring will overcome the trouble, or if there was a blow back plug, change that. Where a screw ring is used, turn it down to obtain a smaller blow back.

I had a safety valve once that was supposed to blow at 90 lb. and after blowing a few times, it would blow down to 60 lb., then it would blow at 60. The spring was adjusted to blow at 90 again, but in a short time it was down to 60. A new spring was then put in and after adjusting it so that it would blow at 90 lb., we had no more trouble.

I saw, in the Dec. 1 issue, page 1177, that Mr. Molloy advises putting more tension on the spring when the valve is simmering until both valves pop at the same time. I would not consider that good advice, because it is dangerous to try adjusting a safety valve with full boiler pressure and at the point of blowing off.

F. C. E.

Inexpensive Boiler Covering

TO REDUCE the loss of heat from the top of my boilers I recently covered one of them with from 6 to 8 in. of coarse ash and then laid over that a mixture consisting of four barrows of coarse ash, one bag of portland cement, and one bag of asbestos cement. This makes a covering sufficiently hard to walk on and is effective in reducing the radiation to a considerable extent. Some opposition has been advanced, however, on the grounds that impurities in the ash such as sulphur, etc., will react on the boiler plate. I would like to have your opinion on this matter before covering the remaining units. H. E. M.

A. Coal ash consists almost entirely of mineral oxides and silicates, even though the coal from which this ash is a residue may have contained considerable quantities of sulphur either in the free state or combined with iron as pyrites. This sulphur is all consumed during the process of combustion and almost none of it is left in the ash. As all the active chemical constituents of coal are consumed in the process of combustion, the ash residue is practically inert chemically and will therefore have no ill effects on any iron or steel with which it may come in contact. It can therefore be used with comparative safety as a cheap covering for the tops of boilers.

Compressor Capacity for Small Sharp Freezer

I HAVE a refrigerator chest or box 14 ft. long by 7 ft. wide by 7 ft. high that is divided lengthwise into two parts, one 5 ft. long and the other 9 ft. It is desired that the first be a sharp freezer to freeze below zero. The other should be able to maintain a temperature from zero to 32 deg. F. What size ammonia compressor must I use for direct expansion and how much pipe surface will be required in each compartment? P. L.

A. No definite answer can be given to this question because all of the factors having an effect on the heat loss are not known; however, by assuming normal conditions and a certain value for the heat loss, we can find from handbooks on the subject certain empirical values that will probably be not far from correct.

With what is known as excellent insulation, i.e., a loss not in excess of 2 B.t.u. per sq. ft. of surface per degree difference in temperature per hour, on a small storage space such as this, it is found that to maintain a temperature at, say—5 deg. F., there will be required about 1000 ft. of 1-in. pipe for direct expansion and that about 1 T. of refrigerating capacity will be needed. The larger compartment to be kept at say 10 deg. F. will require about 225 ft. of 1-in. pipe and about 0.25 T. capacity. The total compressor capacity for the whole chest will therefore be about 1.25 T.

Cylinder Lubrication

THE QUESTION propounded by C. A. T. in the Nov. 15 issue is one that has bothered the writer for some years, for it does seem that if the marine engineers are able to operate their engines without oil lubrication, the stationary men should certainly attempt to follow the same practice. Perhaps the primary reason for the marine man's not using oil in the cylinders is the fact that the conservation of all condensed steam and its continual re-use in the boilers is of tremendous importance. On a steamer, ordinarily, a supply of fresh water is not available in any quantity, hence the steam must be condensed and used over time and time again. If lubricating oil were used in the cylinders, this would introduce oil into the condensate, and would necessitate elaborate filters (for which space was not available), or it would entail running the risk of getting oil into the boilers, a condition that would be extremely dangerous. It might be argued that oil extractors could be used, but it does not seem possible to convince the marine engineer that oil can be removed from either the steam or the condensate, hence he refuses to take a chance.

Consequently, they do not use oil, but do permit perhaps a larger percentage of moisture and water in the

live steam than is ordinarily permitted in stationary practice. Perhaps that is why we hear of broken cylinder heads more frequently in marine service than in stationary practice.

In marine work, also, there is probably more careful and constant watch on the performance of the engines than there is in stationary work where plenty of oil is used, and hence where the possibilities of excess wear are greatly reduced.

As a result of this lack of lubrication, it is necessary to take down marine engines for reboring, etc., more frequently than is the case with engines lubricated with oil.

It appears to be a case merely of where the marine engineer cannot take even the slightest chance on getting oil into his condensate, and from there back into the boilers, and rather than take this risk, the marine man is willing to keep closer watch on his operation, and pay the price of more frequent overhaulings than would be called for if advantage were taken of the friction savings effected by use of proper lubricating oil.

M. A. SALLER.

First Class Engineers' Questions and Answers

ON STARTING a Terry turbine connected to a centrifugal boiler feed pump, the pressure builds up to only 100 lb. in the feed line. What is the trouble? The pressure is supposed to be carried at 200 lb. per sq. in.

A. The pump is steam bound. This is due to the suction head not being high enough and the feed water temperature is too high.

2. With an extraction type turbine, if the relief valve opened up on the extraction line and on relieving some of the spring tension on the diaphragm you found that this did not lower the pressure, what would be the trouble?

A. The diaphragm which operates the pilot valve of the extraction gear is broken.

3. What is the split baffle that is used on the large Heine boilers?

A. This is the middle baffle of the large through baffle boilers. It is of cast iron and is placed on the tubes when the boiler is erected. To remove it after it has been bricked in, hooks are made which fit into lugs on the baffle. They are drawn between the tubes to the top row of tubes.

4. Is it possible to get compression so high in an engine cylinder that the safe working pressure will be exceeded?

A. The relief valve will open or the steam valve will lift from its seat before this condition could exist.

5. What is a balanced valve?

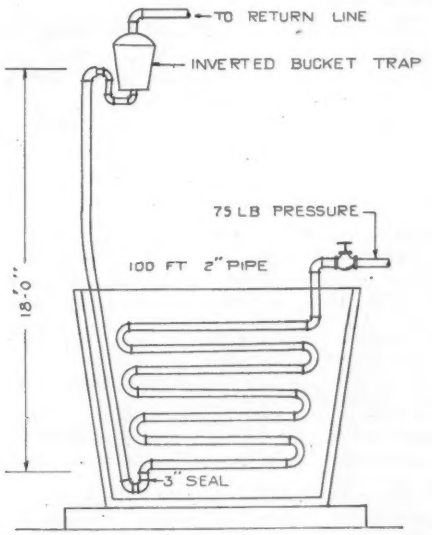
A. A balanced valve is one that has a pressure plate which keeps the steam pressure from bearing on the top of the valve. The pressure plate is kept from resting on the valve by distance pieces between it and the valve seat. There is a clearance of about 0.005 in. between the valve and the pressure plate.

6. What provision is made in the design of the valve to keep the pressure from accumulating between the pressure plate and the valve?

A. If steam leaks between the pressure plate and the valve, it will pass to the exhaust through the hole in the center of the valve. S. T. J.

Trap Installation

I HAVE NOTICED the trap installation discussion on page 924 of the Sept. 15, 1922, issue, especially the criticism by Wm. Ehrlich where he states that a trap must be installed in the lowest point of a steam line to relieve the condensation. I do not agree with Mr. Ehrlich in this respect, if the proper trap is installed. The accompanying figure shows an installation which I made with an inverted bucket trap to prove my theory and the trap is working to perfection. The trap drains a 2-in. spiral



TRAP INSTALLED ABOVE LINE TO BE DRAINED IS ABLE TO HANDLE ALL THE CONDENSATE

coil in an 8 by 8-ft. vat. The trap is placed 18 ft. above the lowest point of the coil, which has 75 lb. steam pressure at the inlet. FRED A. HERR.

Method of Cleaning Discolored Metal Parts

ON PAGE 1223 of the Dec. 15 issue there is a question by F. B. B. in which he inquires as to a method to be used to keep his polished steel parts in good condition. I use a method which I discovered accidentally and I find it very satisfactory. Get some charcoal, break it up fine and mix it thoroughly with machine oil. When thoroughly mixed, smear your rags with this solution and rub the discolored parts of your engine good and hard. Do not clean it off immediately if possible. Leave the mixture on a few days, then clean off thoroughly with a soft rag and your engine will shine as new.

P. J. MOLLOY.

COAL PRODUCTION in Germany during the first 8 mo. of 1922 amounted to 89,282,690 T., as compared with 115,300,836 T. in 1913, exclusive of the Sarre and the Palatinat. The lignite production in the same period amounted to 89,480,334 T., as compared with 56,658,980 T. in 1913.

POWER PLANT ENGINEERING

Trade Mark, Reg. U. S. Pat. Office

Issued the 1st and 15th of each month. Established over 27 yr.

Published by the TECHNICAL PUBLISHING CO.

537 South Dearborn Street, Chicago.

New York Office, 150 Nassau St.

Subscription price $2.00 a year in the United States and all its possessions. Canada $2.75 a year. All foreign countries $3.50 a year.

Copies, current issue, 15 cents; back numbers, 25 cents.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1923, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers.
Member, Audit Bureau of Circulations.

Circulation of this issue, 21,000.

CONTENTS

New Plant at the Bayway Refinery. Illustrated.....109
Proper Draft Control Essential to Use of Moist Fuels. By Zuce Kogan. Illustrated.....118
Many Schemes Used in Handling Ashes. By John Hunter and Alfred Cotton. Illustrated.....121
Uniflow Engine, Principles and Design—III. By Fred William Bosch. Illustrated.....124
Use of the Bleeder Turbine in Industrial Plants. By J. L. Moore. Illustrated.....126
Effect of Oiling on Diesel Engine Operation. By M. S. Howard.....128
Motor Applications in the Lumbering Industry. By Gordon Fox. Illustrated.....130
Electric Power Development in 1922. Illustrated.....132
Work on Cahokia Station Under Way. Illustrated.....135
Air Cooling by Mechanical Refrigeration. By Jewell B. Williams.....137
Foreign Developments Promise Higher Economy. By J. H. Blakey. Illustrated.....138
Heating with Condensing Water Reduces Cost. Illustrated.....139
Primitive Method Saves Delay. By Charles N. Shaw....140
Letters Direct from the Plant: Hangers and Braces for Steam Piping. Underground Pipe Repair. Aids to Burning Clinkering Coals. Regarding the Master Mechanic. Locating Stay Rods in Brick Wall with Spirit Level. Leveling with a Hose Full of Water. Corroded Pipe Causes Rattling. Obtaining the Pitch of Thread in a Tapped Hole. Illustrated.....145
Questions and Answers: Methods of Cleaning Steam Condensers. When Is Safety Valve Too Large for Boiler? Ammonia Gas Trapped in Open Pipe. Loss Due to Combustible in Refuse. Boiler and Furnace Efficiency. Elimination of Oil from Boiler Feed Water. Water Hammer in Boiler Feed Line; Pop Safety Valve Operation. Inexpensive Boiler Covering. Compressor Capacity for Small Sharp Freezer. Cylinder Lubrication. First Class Engineers' Questions and Answers. Trap Installation. Method of Cleaning Discolored Metal Parts. Illustrated.....144
Editorial. Prepare to Store Coal. While Argument Proceeds Power Goes to Waste. Ash Handling.....148
Off Duty.....149
Yearly Index.....149
Enclosure Protects Switch from Dust. Illustrated.....150
Back Pressure Valve Is Arranged for Remote Control. Illustrated.....150
Blowoff Valve Has Reseating Feature. Illustrated.....151
New Line of Small Vertical Compressors. Illustrated....151
Minnesota to Have $80,000,000 Power Development.....152
Pacific Gas & Electric Co. Reports Good Increase in Business.....153
News Notes.....153
Catalog Notes.....156

Prepare to Store Coal

That the interests controlling the coal mining industry have now found the practice which seems to satisfy them is quite apparent from the outcome of the meeting, held recently in Chicago, of bituminous coal operators and mine union officials. The mine workers rejected the operators proposal that wage negotiations be made by districts, which would divide the country into 15 units, the unions insisting on the four state agreement or some variation of it.

Thus this conference ends with practically nothing accomplished and another is scheduled to be held in New York, probably Jan. 18. Such conferences have been held for somewhat over a year now at more at less regular intervals with similar results;—nothing.

With a coal strike every summer, the production is curtailed to such an extent that buying becomes panicky and prices jump to the top notch, with the mine operator as the winner. Then who can blame the mine worker for holding out for high wages and a monopoly of mine labor when his work calls for employment only seven to nine months of the year?

However well those in the coal industry like the arrangement of a strike every summer, it is anything but pleasing to the coal consumer who must not only pay an exorbitant price for his fuel but faces continually the possibility of a shutdown due to a coal famine.

Only one method of combating the evil of strikes in the coal fields is open to the average power plant owner, and that is to keep sufficient coal in storage to tide the plant over any strike period likely to occur. It is an expensive method but not nearly so costly as being caught short of fuel and compelled to pay famine prices to avert a shutdown.

On April 1 the present agreement between the mine operators and the miners terminates. There seems to be little likelihood that the parties concerned will come to an agreement in time to prevent ceasing of operations on April 1. There is of course the possibility that the Government will step in and force a settlement but we have no assurance of this.

Every manager of a power plant will do well to watch developments in the coal mining industry and be prepared to store coal in sufficient quantity before mining operations cease.

While the Argument Proceeds, Power Goes to Waste

During the past year, there have been a number of cases of conflicting opinion over the granting of rights for the use of water power. While the Muscle Shoals development was the one which attracted the interest of the general public, there have been several other cases where the principles involved were no less important

One of these controversies has been that between the Northern States Power Co., Henry Ford, and the cities of St. Paul and Minneapolis, over which interest should be granted permission to build a plant at the High Dam, constructed by the Federal Government, on the Mississippi River between these two cities.

While all of the interests involved usually have good arguments to back their side of the case, the fact remains that the delayed settlement of such developments frequently causes an economic waste of startling propor-

tions. At St. Paul and Minneapolis, the Federal Government spent some $2,000,000 on the dam and during the years the project has stood idle it is said that the losses have amounted to $700,000. At the same time, coal has had to be transported to these cities, which might well have been conserved by using this water-power.

In all such cases, it would seem that some method might be worked out which would lift these decisions out of the maze of political intrigue, personal ambitions, municipal glorification and corporation interests which now make it almost impossible to arrive at a solution which is based on the best interests of all the parties.

Ash Handling

One feature of plant operation which is yet in the primitive stage in many plants, is the method of handling and the disposal of ashes. Possibly the comparative lack of interest in this subject may be traced to the operating man's viewpoint that ashes are at best a necessary evil and that the method of handling and disposition are not of sufficient economic importance to warrant a study from purely efficiency standards.

In the past few years, however, increasing costs of labor, trucking, rail and boat transportation have necessitated a somewhat changed attitude toward this factor in plant operating costs. Operators have discovered, on analysis, that the cost of ashes were out of all proportion to other plant expense. As a result there has been considerable activity in the study of efficient handling methods and rapid strides have been made in the design and development of apparatus for such work.

At the annual meeting of the American Society of Mechanical Engineers much interest was aroused in a discussion of Ash Handling by John Hunter and Alfred Cotton. Elsewhere in this issue an abstract of this paper takes up some of the problems which are involved in the laying out of a system for handling ashes in various types of plants. From the points presented in this article and the discussion at the A. S. M. E. meeting it is evident that plant engineers can well afford to analyze their ash handling methods with a view toward determining whether improvements are possible and practical.

Off Duty

Well, here we are starting out upon another half-billion-mile lap around the solar orb, and if for nothing else we can thank our lucky stars that we will not have to pay for the journey at the rate of three or four cents per mile as we do on the railroads. Fortunately, that is one thing about which we do not have to worry.

There are plenty of other things, however, about which we as engineers can do a little worrying or rather a little thinking. With the closing of the year 1922, for instance, we find ourselves just one step nearer to the end of our coal and oil resources, and not much nearer towards solving the problem of future power supply. While our coal resources are sufficient to guarantee our needs for a good many years to come, it cannot be denied that ultimately they will come to an end, and long before the last ton of coal is mined its accessibility will have become increasingly difficult. With our oil resources, the situation is far more acute and if the amazing estimates of 20 to 30 yr. for the remainder of our oil supply are exaggerations, what will it avail even if we stretch them to a hundred or even two hundred years? With the rapidity at which we are depleting our energy resources, it matters little whether their life be 20 yr. or 500 yr.; the end is in sight and when it comes we shall have to be ready to provide something else. In the short span of a century or two, we are squandering the energy which for ages and ages before, the sun had been storing up.

While the unconcern with which the average individual regards, or let us say disregards these matters, is truly astonishing, it is nevertheless encouraging to know that there are groups of men sufficiently interested in the problem to discuss its solution. In Boston at the recent meeting of the American Association for the Advancement of Science, there was presented a symposium on Photo-synthesis and the Possible Use of Solar Energy. Photosynthesis! you exclaim, and throw up your hands in dismay. But do not be frightened. It is not a disease and this meeeting was merely an attempt to learn the more important details of the manner in which plants utilize the energy sent daily from the sun, and to try to devise a means for using that energy more efficiently than plants themselves have been able to use it.

It is probably a well known fact that all life upon this earth is dependent upon a continuous supply of energy derived from food. Of course, insofar as the food material itself is concerned there exists a closed cycle. Man and animals feed upon plants, and the plants feed upon the carbon dioxide given to the air by man and animals as a result of using food. The part which the plant cell plays in reconverting the waste products of animal metabolism into food has been termed photosynthesis. The CO_2 formed in our furnaces and which is also exhaled by animals is absorbed by the plant and by means of light from the sun is changed into materials such as sugar and wood, which can be used either as food or fuel. In fact, food itself is nothing more nor less than fuel for living machines and the ultimate product whether it be burned in the furnace or in the body of an animal is the same, namely, CO_2.

Now the important thing about these two processes, photosynthesis and combustion, is the fact that energy changes are involved. In the burning of fuel or of food to CO_2 a certain amount of energy is liberated. Conversely, in the reconversion of CO_2 into food or fuel through the agency of the plant, energy is absorbed. This energy is supplied by the sunlight.

It is obvious, therefore, that if we can learn some of the secrets of the plants and thus devise a more efficient or more rapid means of utilizing the energy of the sunlight by the conversion of carbon dioxide into food or fuel, we shall have at our disposal an abundant supply of power as long as the sun continues to shine.

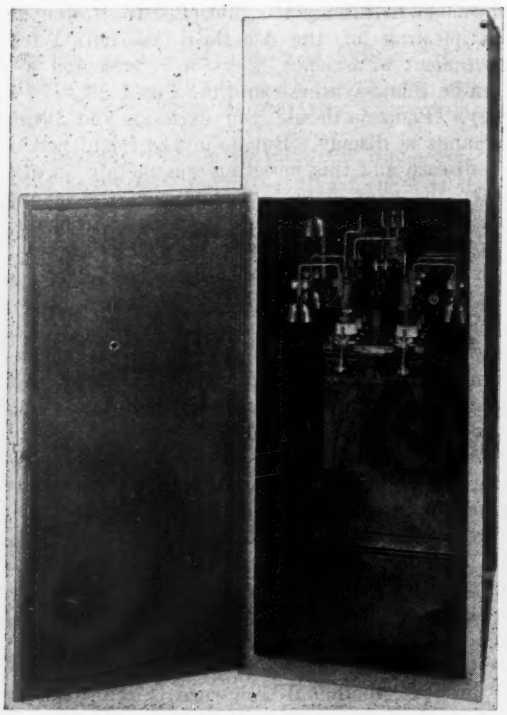
Exactly how the plant cell accomplishes its function as an intermediary is as yet a mystery, but some of the steps in the process are now understood and have been duplicated artificially, and others will follow. Upon the correct solution of this problem rests the true independence of mankind and it is to those chemists and physicists engaged in the work of unravelling these biochemical mysteries that we must look for the answer.

Yearly Index

INDEX for Volume XXVI of Power Plant Engineering is now prepared and will be sent free to subscribers upon request.

Enclosure Protects Switch from Dust

IN PLACES where circuit breakers are exposed to fine dust or particles of the manufactured product, such as in the case in cement mills, there is an ever present danger of a ground due to the absorption of moisture by the coating of dust on the breaker. To overcome this danger, the General Electric Company has designed the dust proof switch house shown in the accompanying



DUST PROOF SWITCH HOUSE WITH 600-V. OIL CIRCUIT BREAKER (REAR VIEW)

illustration. The new house is similar to a standard portable steel switch house, with the addition of the specially designed dust-proof feature.

The ends of the doors of the housing are shaped into hollow squares into which are inserted felt packing doubled about a soft rope. This packing will compress or expand to fit the irregularities of the door and frame and is well protected from wear, because of the opening and closing of the doors, by the sheet metal square into which it is inserted.

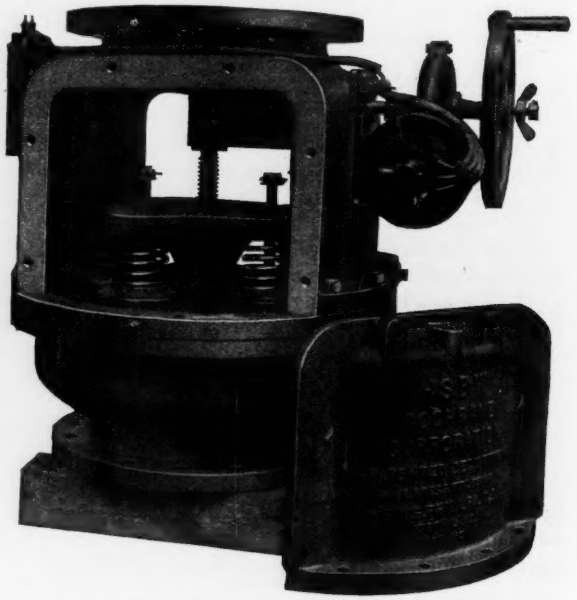
Another precaution is that the compartment in front of the panel is completely isolated from the rest of the housing, so that when the front door is opened to operate the breaker no cement or dust can penetrate to the compartment containing the breaker unit.

A test was made of this dust proof switch house by placing it in a sand blast house. The air blast outlet was placed in the pit so that the powdered sand would be blown backward into the blast house; in this manner, the powdered sand, which is as fine as flour or cement, was whirled at the switch house under excessive pressure for 2 hr. When the switch house doors were opened, not a trace of sand was found within any of the compartments.

Back Pressure Valve Is Arranged for Remote Control

WHERE exhaust steam is used for heating buildings or for drying or other industrial processes, the back pressure valve is ordinarily located at the top of the building, usually on a vertical exhaust riser. In this location the valve is difficult of access, so that there is a tendency for operating men to carry the same back pressure on the engine at all times, regardless of varying needs for exhaust steam or the back pressure really required. Needless back pressure increases the steam consumption of engines or turbines and may result in a considerable waste of fuel. If the back pressure valve is not only in an inaccessible place, but is also difficult of adjustment, the probability is that unnecessary back pressure will be carried much of the time.

With these points in mind, a new form of back pressure valve has recently been designed. In this valve a



BACK PRESSURE MAY BE REGULATED FROM A CONTROL STATION IN THIS MULTIPORT VALVE

number of small discs are used, instead of one large disc, and each disc is held to seat by spring pressure, the pressure upon all of the springs being regulated simultaneously by a movable pressure plate, the position of which can be adjusted from outside the valve case. If it is desired to operate the valve from a short distance away, as from the floor above or below, chain and chain wheel or bevel gear and rods can be used.

In order to regulate the back pressure from a greater distance, an electric motor control has been devised. The valve can be located on the tenth floor, if necessary, while the remote control panel is placed in the engine room, alongside the back pressure gage. By simply throwing a switch or pushing a switch or pushing a button, the operator sets in motion a motor which drives the pressure plate of the valve through a worm gear, the operator meanwhile watching the pressure gage and pulling the switch open when the right pressure is reached, or the operator can stop the pressure plate at

any desired point. Over-travel of the pressure plate or injury to the motor are prevented by a limit switch attached to the valve casing, as shown in the photograph. The limit switch interrupts the supply of current to the motor, which can, however, be started again by throwing the control switch in the opposite direction.

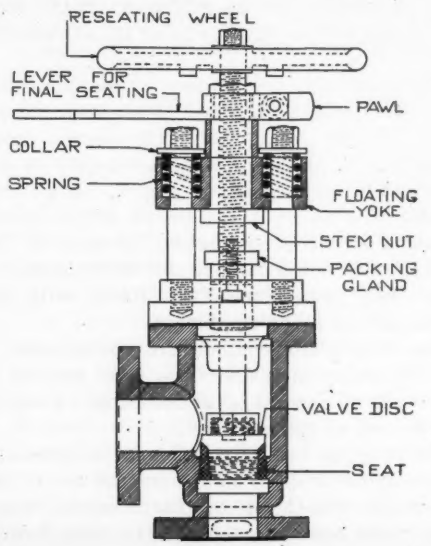
To allow for manual operation a worm wheel is mounted on a sleeve which connects with a hand wheel mounted over a spline on the shaft. The hand shaft is connected to the shaft which drives the valve spindle through a flexible coupling. By loosening a wing nut on the hand wheel, the wheel may be then drawn back from engagement with the worm wheel, and the pressure plate can be lowered or raised manually in case the motor should be out of order or the current supply should be interrupted. The motion of the pressure plate is limited by stops, so that a predetermined back pressure (which is fixed by the strength of the springs used) cannot be exceeded, and since no part connected with the discs extend outside the casing, there is no possibility of jamming by over-tightening of stuffing boxes, or of overweighting or tying down.

Two types of remote control switches are supplied. The knife switch type will remain in either the closed position or the open position indefinitely. A cylindrical swich is also used which must be held closed in order to keep the motor in operation and which flies back into neutral position as soon as released. In addition to the indicating and recording gage, which should be placed near to or just above the switch, two pilot lights are used to show when the valve is entirely opened or closed, respectively.

This valve is manufactured by the H. S. B. W.-Cochrane Corporation of Philadelphia.

Blowoff Valve Has Reseating Feature

ONE feature of the Eckenroth automatic reseating blowoff valve, which was briefly described in the March 1, 1922, issue of Power Plant Engineering, is in the method of securing the grinding action during the period of reseating as the valve is closed.



VALVE DISC UNDER COMPRESSION OF SPRINGS ROTATES ON SEAT UNTIL FLOATING YOKE COMES UP AGAINST COLLARS

By referring to the illustration, it will be noted that the disc is fitted to a square shank on the stem and hence both disc and stem revolve as a single unit. As the disc comes in contact with the seat in closing the valve, compression of springs contained in a floating yoke begins and the disc rotates on the seat with increasing pressure until the springs are entirely compressed. This action has a polishing effect on the seating surfaces which is said to improve them with each operation.

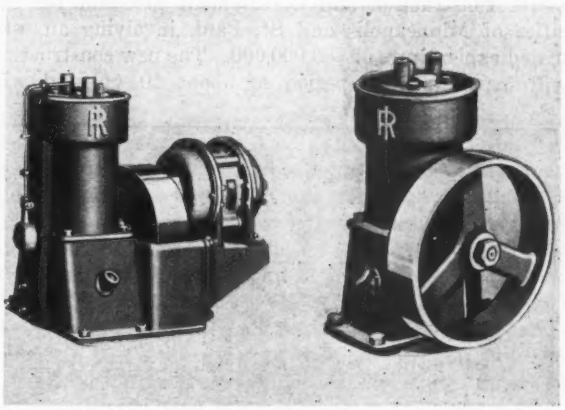
When the valve has been thus closed until the springs are entirely compressed, the valve disc is then firmly seated by moving the lever in the closing direction.

If it is desired to obtain continuous rotation of the valve disc the hand wheel is screwed down as mentioned above, and the lever is engaged with the hand wheel by means of the pawl. As all of the moving parts are thus locked together the lever can then be used for giving any amount of rotation that may be desired. This feature is for use where the seating surfaces may have become encrusted due to valve having been left open for long periods.

These valves are now being distributed by the Hagan Corporation, of Pittsburgh.

New Line of Small Vertical Compressors

SEVERAL interesting features of construction have been incorporated in a new line of small vertical air compressors recently brought out by the Ingersoll-Rand Co., of New York City. Of these features the constant-level lubrication system is the most important.



CONSTANT LEVEL LUBRICATING SYSTEM IS A FEATURE OF THESE SMALL COMPRESSORS.

Others include the constant speed unloader for plain belt drive machines; the centrifugal unloader for start and stop control machines; and the increased size of the water reservoir cooling pot.

As with the ordinary splash system, the base of the compressor forms an oil reservoir for the constant-level system; however, with this system, pet cocks determine the maximum and minimum amount of oil in the reservoir. Above this reservoir and directly underneath the connecting rod is a constant-level pan. Oil is pumped from the reservoir into this pan through an oil pump.

Regardless of the amount of oil in the reservoir, as long as it is somewhere between the high and low level pet cocks, this system will function perfectly, insuring a constant-level of oil in the pan. A projecting stem on the connecting rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication.

Unloading of the compressor is taken care of by the constant speed unloader which automatically opens the inlet valve when the receiver pressure rises above that at which the unloader is set to operate. When the receiver pressure has fallen a predetermined amount, the unloader automatically releases the inlet valve and allows the compressor to return to work and thus build up the receiver pressure again.

In order to allow the compressor to start under no load such as is essential when automatic start and stop control is used, the centrifugal unloader permits the electric driving motor to come up to full speed before the load is thrown on automatically. This unloader accomplishes its purpose by holding the inlet valve open until the motor has reached full speed.

In the smallest size, these units are built with either ribbed cylinder for air cooling, where the service is intermittent, or a water jacketed cylinder of the reservoir type for constant service. All other sizes are built only with the water jacket of the reservoir type. The size of these reservoir pots is very generous, and one filling will be found sufficient for long periods of operation.

Minnesota to Have $80,000,000 Power Development

BYLLESBY Engineering and Management Corporation announces a new electric water and steam power construction and development program for the cities of Minneapolis and St. Paul, involving an estimated expenditure of $80,000,000. The new construction will extend over a period of about 10 yr. and will

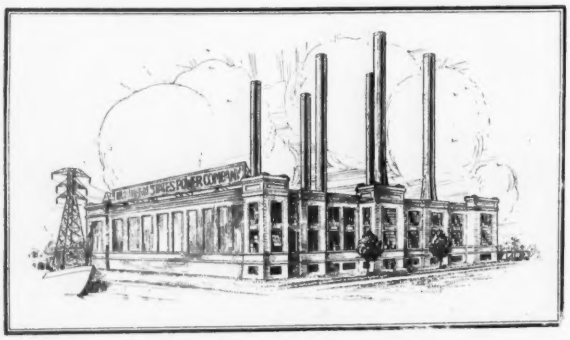


FIG. 1. THIS 100,000-HP. STATION WILL BE BUILT AT ST. PAUL

increase by 306,000 hp. the electric generating capacity of Northern States Power Co., which serves 350 cities and towns in Minnesota, the Dakotas, Wisconsin, Illinois and Iowa, and which is one of the operated properties of Standard Gas and Electric Co.

Work will start at once on the construction of a large steam turbine generating station in St. Paul, as shown in Fig. 1, for which approximately 40 acres have been acquired on the Mississippi River near the High Bridge. The first generating unit to be installed will be 40,000 hp. capacity. It is planned to install 60,000 hp. additional capacity immediately after the first unit is completed making the total initial capacity 100,000 hp. From this point on, during the remainder of the 10-yr. period, additional steam generating capacity of about 100,000 hp. will be added to the Riverside Station in Minneapolis, which now has total capacity of 103,000 hp., and to the new power plant in St. Paul. Total new steam electric generating capacity to be installed will be 200,000 hp.

Authorization has been received from the Federal Water Power Commission for the Northern States Power

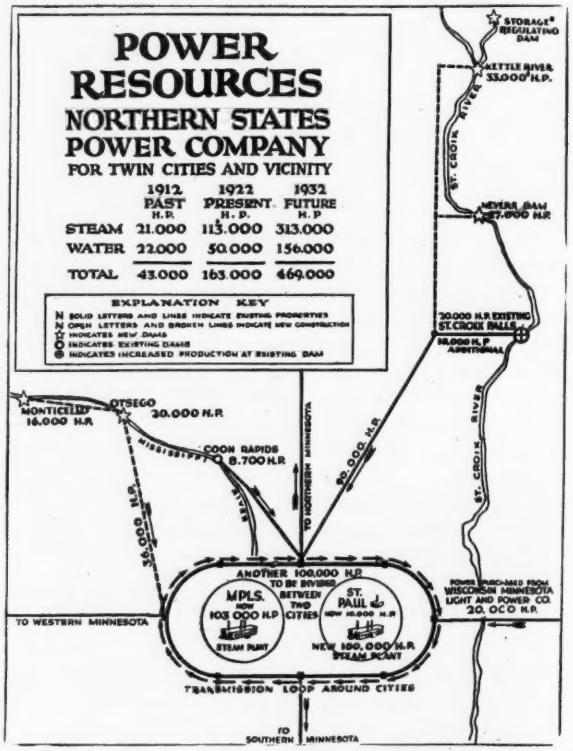

POWER RESOURCES
NORTHERN STATES POWER COMPANY
FOR TWIN CITIES AND VICINITY
1912 PAST H.P.
1922 PRESENT H.P.
1932 FUTURE H.P.
STEAM 21.000 113.000 313.000
WATER 22.000 50.000 156.000
TOTAL 43.000 163.000 469.000
EXPLANATION KEY
STORAGE REGULATING DAM
KETTLE RIVER 33.000 H.P.
ST. CROIX RIVER
MYERS DAM 27.000 H.P.
20.000 H.P. EXISTING ST. CROIX FALLS
40.000 H.P. ADDITIONAL
MONTICELLO 16.000 H.P.
OTSEGO 20.000 H.P.
COON RAPIDS 8.700 H.P.
TO NORTHERN MINNESOTA
ANOTHER 100,000 H.P. TO BE DIVIDED BETWEEN TWO CITIES
MPLS. NOW 103.000 H.P.
ST. PAUL NOW 40.000 H.P.
STEAM PLANT
NEW 100,000 H.P. STEAM PLANT
TO WESTERN MINNESOTA
POWER PURCHASED FROM WISCONSIN MINNESOTA LIGHT AND POWER CO. 20,000 H.P.
TRANSMISSION LOOP AROUND CITIES
TO SOUTHERN MINNESOTA

FIG. 2. NORTHERN STATES POWER CO. PLANS EXTENSIVE WATER POWER DEVELOPMENT IN MINNESOTA

Co. to proceed with development of the power resources of the St. Croix and upper Mississippi Rivers, and 106,000 hp. of additional hydroelectric generating capacity will be added by the construction of the water powers shown on the map in Fig. 2. A water storage dam also will be built in the St. Croix River, eight miles above Kettle River Rapids. In order to distribute the additional power, a new power transmission loop will be built around the Twin Cities, with necessary substations and other equipment.

Financing plans contemplate continuance of customer ownership methods which have created a shareholders' list of upward of 25,000 people, most of whom are customers of the company.

This program has no relation to the present conflict in Minneapolis and St. Paul over the use of the High Dam which was built by the Federal Government several years ago. At the present time four applications have been filed with the Federal Power Commission for the use of this power. The cities of St. Paul

and Minneapolis, Henry Ford and the Northern States Power Co. are the interested parties.

Originally the St. Paul Association induced the city to file an application with a view to promoting a new industrial center and as a part of that plan Henry Ford agreed to build a factory to employ 5000 men. The power rights were then to be transferred to the Ford interests. The city of Minneapolis felt, however, that this plan did not give it a proper share in the development and hence filed an application. At the same time, the Northern States Power Co. also entered its claim on the basis that the most efficient use of the secondary power could be made by operating the development as a part of its system. When the controversy reached this stage, the Ford interests then filed their own application.

Although the Federal Power Commission has held a hearing, it has been decided to postpone action until the Municipal Electric Corporation, composed of the cities of St. Paul and Minneapolis and the University of Minnesota, has an opportunity to secure state legislation to construct and operate the plant. If this goes through, the power will be used strictly for municipal operations.

According to officials of the Byllesby Co., the maximum power expected from a plant at the High Dam would be about 14,000 hp. The Government has spent some $2,000,000 on the dam and in the interests of conservation it is thought that some action should be taken. Just what will finally be decided by the Federal Power Commission in the event of further delay remains yet to be seen.

Pacific Gas & Electric Co. Reports Good Increase in Business

Reports that its operations reflect a continuation of improved business conditions in Northern California, which have been apparent for several months, have been made by the Pacific Gas & Electric Co. Additional gas and electric customers indicate growth in population and building activity, and the largely increased consumption of electric power for manufacturing and commercial purposes is a fairly correct gage for measuring the revival of industry.

About the middle of October the new Pit River No. 1 power plant was placed in operation and now has an output bordering on 1,000,000 kw.-hr. per day. It is something new in the annals of hydroelectric development in California to place in operation during the season of the year when the normal stream flow is at its lowest, a water power plant which at once is capable of operating at practically its maximum capacity, thus substantiating the claim heretofore made, that these Pit River plants are almost independent of seasonal precipitation. A large proportion of the output of this plant is, of course, required to take care of the very substantial new business which is being taken on; but the operation of the new plant also reflects to the company's advantage in permitting of a considerable reduction in steam-generated energy and power purchased from other companies.

During October, for example, with Pit River No. 1 in operation only part of the time, the company's hydroelectric output increased 13,642,381 kw.-hr., or 17.1 per cent, while the aggregate of steam-generated energy and purchased power decreased 4,436,883 kw.-hr., or 9.7 per cent. These figures indicate that the company's expenditure of approximately $20,000,000 on the Pit River developments is being justified by results.

During the year, up to Dec. 6, 1922, the company made sales, aggregating $9,593,200 par value, of its first preferred 6 per cent stock. There now remains for sale from the last $5,000,000 authorization of the railroad commission only a trifle over half a million dollars' worth of stock, and it is anticipated that this comparatively small balance will be subscribed for by local investors within the next two or three weeks. There are now over 24,000 partners in this enterprise, the greater majority of whom reside in Northern and Central California.

Clark Thread Co. Decides to Use Pulverized Coal in Rebuilt Plant

After a study of how its present hand-fired boiler plant might be improved, the Clark Tread Co., of Newark, N. J., has decided to utilize powdered coal for firing.

According to present plans, the capacity of the pulverizing plant will be 10 to 12 T. per hr. The coal will be dried in one 4 ft. 6 in. by 30-ft. indirect fired dryer using pulverized coal for fuel. The coal will be pulverized in two 46-in. mills, screen type, gear driven. The pulverized coal will be conveyed from the mills to the boiler bins, a distance of about 600 ft., by means of the Fuller-Kinyon conveying system for pulverized materials; this system contemplates delivering the coal through a 5-in. line, distributing to the individual service bins through 10 two-way switching valves connecting the main line with branch lines. This conveying system will be equipped with electric-pneumatic control, by which the coal can be diverted from the main line through any of the switching valves by the operator in the coal house. Also the condition of the coal supply in each bin will be indicated by lights automatically operated on the switchboard in the coal house, so that the mill man will have constant knowledge of the fuel conditions throughout the plant.

There will be ten 500-hp. Stirling boilers, each one equipped with three pulverized coal feeders and three vertical flare type burners. The boilers will operate normally at 125 per cent to 150 per cent of builder's rating, and will be so arranged that either pulverized anthracite or pulverized bituminous coals can be used.

Equipment for the plant will be furnished by the Fuller-Lehigh Co., of Fullerton, Pa.

News Notes

Gordon & McNeal Co., 50 Church St., New York, has been appointed representatives of the Union Iron Works, of Erie, Pa., succeeding E. H. Ludeman.

O. C. Keckley Co., Chicago, announces the appointment of T. J. MacMaster as manager of its Specialty Department.

Effective Jan. 1, 1923, Edwin L. King is appointed district sales manager for the Reading Steel Casting Co.,

Inc., with headquarters at 208 South La Salle St., Chicago, Ill., to succeed M. L. Chase, resigned.

McClave-Brooks Co., of Scranton, Pa., maker of McClave grates, combustion systems and Argand blowers, has announced several changes in its sales organization. A. R. St. John, now of the New York office, will become manager of the Syracuse office, and George Blair, Jr., manager of the Philadelphia office, will assume the duties of manager of the New York office, incorporating the New York and Philadelphia territory into one; D. G. Counts will become manager of the newly opened office in Memphis, Tenn., and will continue the managership of the Dallas office. The states of Virginia and Florida will be added to the territory of J. C. Sanders, Greenville manager, and a new office will be opened in Greensboro, N. C., under Mr. Sanders' managership.

R. R. Knapp, who was formerly associated with E. L. Newcomb, of Brooklyn, N. Y., in the manufacture of springs, has been appointed sales manager of the Hunter Pressed Steel Co., of Lansdale, Pa. The business of this organization has expanded to the point where it has become necessary to build an addition to the factory to be used for office purposes.

On Dec. 11, 1922, Howard E. Eddy, formerly identified with Manning, Maxwell & Moore, Inc., of New York, became vice president and general manager of the Nelson Valve Co., and on the same date C. W. Brown, of Philadelphia, became secretary and treasurer. C. D. Miller, formerly identified with the Bridgeport Works of Manning, Maxwell & Moore, Inc., became works manager and C. W. Burrage, of the same company, became mechanical engineer.

E. T. Fishwick, formerly sales manager of the Worthington Pump & Machinery Corporation, has been made vice president in charge of sales to succeed F. H. Jones, vice president, who recently resigned. J. E. Sague, vice president, resigned, is succeeded by William Goodman, formerly assistant to the vice president. James C. Barnaby, formerly plant engineer of Staten Island Shipbuilding Co., will be in charge of certain engineering work in Diesel oil engine division of Worthington Pump and Machinery Corporation.

Fred A. Marsh, general purchasing agent of the Link-Belt Co., died at his home in Chicago, on the evening of Dec. 11, at the age of 52 yr. Mr. Marsh was a member of the Link-Belt organization for over 33 yr.; was one of the organizers of the Purchasing Agents' Association of Chicago, and served ably as the first president; has been for some years a director in the National Association of Purchasing Agents; and will be remembered by his large circle of business acquaintances as a particularly well informed man in his line, of sterling character, absolutely impartial in his treatment of sellers, buying on merit, and an honor to the important business profession of purchasing agent.

Alfred B. Carhart has resigned his position as vice-president and sales manager of the Crosby Steam Gage and Valve Co., to become president and general manager of the Precision Instrument Co., Inc. Mr. Carhart was for more than 10 yr. works manager of the Crosby factory and has had a large practical experience in manufacturing as well as in sales. He is a mechanical and electrical engineer, a graduate of Princeton and before going to Boston was connected with other successful manufacturing companies in New York. The Precision Instrument Co., Inc., has acquired control of the Precision Instrument Co., of Newark, N. J., manufacturers of "3 in 1" draft gages, pressure recording instruments, CO_2 recorders, specific gravity recorders, laboratory gas meters, gas calorimeters and other lines. The present executive officers, who have been so successful, will retain their connection with the company. It is expected to enlarge the business considerably, with new capital, adding other specialties, besides staple lines of gages, valves and fittings. Mr. Carhart will assume the new duties at once. The company's New York office will be in the Engineering Building, 114 Liberty St. The factory will later be moved to New York.

Liptak Fire Brick Arch Co. will move its main office from Minneapolis to 20th St. and Prairie Ave., Chicago, on Feb. 1.

Wilson Welder & Metals Co., of New York, now represented exclusively in Maryland, Virginia and the District of Columbia, by the Alexander Milburn Co., of Baltimore.

Warren Webster & Co. announces the opening of an office in Los Angeles, Calif., at 306 Crocker St. It will be operated as a direct branch office and will be in charge of R. M. Gunzel.

Maxwell W. Robertson, who for 15 yr. prior to 1920, was general manager of the Le Valley Vitae Carbon Brush Co., announces that he has acquired by purchase, its entire plant and business and right to the use of its corporate name. From now on, its operations will be under his personal supervision.

Manning, Maxwell & Moore has appointed William P. Bradbury, sales manager for the products of its brass goods plants which are made up of Ashcroft Manufacturing Co., Consolidated Safety Valve Co., Hancock Inspirator Co., Hayden & Derby Manufacturing Co., with headquarters at 119 West 40th St., New York, N. Y.

Announcement has been made by the Ingersoll-Rand Co. and the A. S. Cameron Steam Pump Works of the opening of a branch office in the Ellicott Square building, Buffalo, N. Y. This new office is equipped to render service to those interested in air, gas and ammonia compressors, vacuum pumps, turbo blowers and compressors, condensers, oil and gas engines, pneumatic tools, rock drills, centrifugal and direct-acting pumps and other of the numerous products manufactured by these companies.

George W. Galbraith, sales manager of The Worthington Pump and Machinery Corporation, Cincinnati branch, has been elected president of the Engineers' Club of Cincinnati for the year 1923. Mr. Galbraith's first official act will be to inaugurate a campaign for funds for the erection of an engineers' building. The building will be an eight-story structure in which will be provided quarters for the Engineers' Club, offices for consulting engineers and architects and sales rooms on the first floor, according to Mr. Galbraith.

Control of the Ground Coal Engineering Co. of Chicago, designers and builders of pulverized fuel installations, has been acquired by the Sanford Riley

Stoker Co. This will supplement the company's stoker work for industrial furnaces which is an important and growing part of the Jones stoker business. The Ground Coal Engineering Co. has been incorporated in Massachusetts. It will be a subsidiary of the Sanford Riley Stoker Co. with headquarters at Worcester. R. Sanford Riley is president and M. W. Arrowood, vice-president. The company holds valuable patents on the burning of coal by the Arrowood "multi-mix" burners. The Underfeed Stoker Co. of Canada, Ltd., Toronto, will represent this company in Canada. The headquarters of Wm. Pestell, sales manager of the Sanford Riley Stoker Co., have been transferred to Worcester, Mass., from New York. The New York office will be retained at 103 Park Ave.

UNCLE SAM offers you the opportunity to continue to save safely and profitably by exchanging W. S. S. (Series of 1918) for Treasury Savings Certificates. Ask your pastmaster or bank for particulars. They will handle the matter for you.

REMARKABLE, nation-wide interest in foreign markets, reflected by a 400 per cent increase in inquiries directed to the Department of Commerce by American business establishments of all kinds, during 1922 over 1921, is disclosed in the annual report of Director Julius Klein, of the Bureau of Foreign and Domestic Commerce.

ON DEC. 8 the Ceres power house of the Olean, Bradford & Salamanca Railway Co., Olean, N. Y., was badly damaged by fire when a container of lubricating oil became overheated and burst into flames. One wall and the roof were burned away. Electric cables and pipes were damaged. The plant will be rebuilt, according to road officials.

AT MEXICO, MO., the Missouri Utilities Co. is installing a 1250-kw. bleeder type Westinghouse turbo generator, complete with Alberger condenser and spray pond. One 35-kw. motor generator exciter is included in the turbine installation. A one story brick building 20 ft. by 45 ft. is also being erected to enclose the water works equipment and one 10-in. two-stage Alberger pump is being installed, driven by a 125-hp. steam turbine, for fire pump service.

ONE OF THE largest electric power plants in the South will be erected on the Houston ship channel below the turning basin, it is officially announced by the Houston Lighting & Power Co. of Houston, Texas. Tentative plans call for a power station that will generate 50,500 kw. The present Gable street station will be retained as an auxiliary station. It now generates 32,500 kw. The new plant is to be ready for operation in 1924. Meanwhile the company believes the present station will take care of the needs of Houston.

PROTECTION OF ELECTRIC power systems by the adequate use of lightning arresters was discussed before a meeting of the Pittsburgh section of the American Institute of Electrical Engineers, by D. W. Roper, superintendent of Street Department of the Commonwealth Edison Co., of Chicago, on Dec. 12. Mr. Roper covered the principles of design as exemplified by some of the most recent types of lightning arresters which have been placed on the market. He also touched upon the application of this type of apparatus for the protection of systems.

CONSTRUCTION WORK, which increased the capacity of its plant, enlarged the canal and forebay, and cost in excess of $650,000, was completed recently by the Cohoes Power & Light Corporation, of New York. The principal feature of the work was the enlargement of the canal area above the power plant. The work entailed the widening of the forebay at the power house, the widening of the canal along its mile and one-eighth length. This work was started March 20, 1922. With the increased area of the forebay, the power plant will now receive enough water to operate at its 40,000-hp. capacity, and also to take care of the increased 15,000-hp. capacity which will be given by the installation of a new unit early in 1923. The canal, from the power plant to the extreme end, now has an average width of 130 ft., an increase of approximately 50 ft. The waterway has an average depth of 9 ft.

BIDS WILL BE received by the city council of Shelbyville, Ill., until Feb. 5, for furnishing and constructing a complete municipal electric light and power plant including power house building, concrete or brick chimney, water-tube boilers, hand stokers, steel coal bunker, belt coal conveyor, boiler feed and circulating pumps, surface condenser heater, uniflow non-releasing Corliss engine or turbine, piping, generators, exciters and regulators, switchboard, poles, street light fixtures, line supplies, etc. W. A. Fuller Co., St. Louis, Mo., are the engineers.

AN ISSUE of $1,500,000 Nevada-California Electric Corporation 6 per cent first lien gold bonds, series "B," due in 1950, is being brought out by Blyth, Witter & Co. and others. The bonds are a direct obligation of a California hydroelectric company serving a prosperous diversified and rapidly growing territory. The bonds are secured by a direct collateral lien on all the properties of the system through the pledge of mortgage bonds and stocks of subsidiary companies. The company's plants, now installed have a generating capacity of 77,630 hp., of which 66,130 hp. is hydroelectric. Total property value of the entire system is placed at $25,195,726. Total bonds and secured note indebtedness is $16,092,000.

CONSTRUCTION OF a $500,000 addition to the Northwestern Electric Co. of Portland, Ore., steam generating plant at the foot of Lincoln St. and the installation of new tie lines and equipment to cost $400,000 more have been ordered to proceed at once, according to L. T. Merwin, vice-president and general manager of the company. The improvement will be rushed to completion within eight months. The capacity of the present steam plant on the river front will be doubled. This plant now has a capacity of 13,000 hp. The company also maintains a steam plant under the Pittock block that has a capacity of 7500 hp. When the newly ordered addition is completed the total capacity of all the steam generating facilities of the company in Portland will be 31,500 hp.

U. S. CIVIL SERVICE COMMISSION announces the following open competitive examination: Associate Mechanical Engineer (internal combustion engines), to fill a vacancy in the position of engineer of tests at $10.56 a day, for duty in the aeronautical engineering laboratory, Navy Yard, Washington, D. C., and other

such vacancies should they occur later. The receipt of applications will close on Jan. 30. The duties of the appointee will be to act as technical advisor to the officer in charge and to take actual control of testing and designing work. Competitors will not be required to report for examination at any place, but will be rated on their education, experience and fitness. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or secretary of the board of U. S. civil service examiners at the post office or customhouse in any city.

Catalog Notes

EMPIRE fuel oil meters are the subject of a booklet from National Meter Co., 299 Broadway, New York.

ECKENROTH automatic reseating blowoff valves are described in a bulletin which has recently been brought out by the Hagan Corporation, of Pittsburgh, Pa.

LINK-BELT calendar for 1923 illustrated with views of the company's cranes, silent chain drives, and other products, has just been received.

INSTRUCTION BOOK No. 19, issued by the Smooth-On Mfg. Co., Jersey City, N. J., gives numerous suggestions as to the use of Smooth-On cements and illustrates a number of unusual applications which have been made.

"THIRTY-FIVE YEARS' PROGRESS BOILED DOWN" is a booklet issued by the Dearborn Chemical Co., of Chicago, which shows how this organization has handled the water problem.

PUBLICATIONS have lately been received from B. F. Sturtevant Co., Boston, as follows: Catalog No. 291, Sturtevant Pneumatic Collecting and Conveying Systems; and Bulletin No. 296, on the Sturtevant Unit Heater.

CATALOG No. 30 of the Homestead Valve Manufacturing Co., of Homestead, Pa., takes up the various types and uses of Homestead valves, including the new type of quarter turn lubricating valves which have been brought out recently by this company.

BULLETIN 1122 issued by the Esterline-Angus Co., is entitled "How to Make a Plant Survey." It is devoted to a discussion of the purpose, method and the results obtained by the systematic use of graphic instruments in industrial plants.

WE HAVE just received an attractively illustrated calendar for 1923 from The Brown Hoisting Machinery Co., of Cleveland, Ohio. The illustrations take the form of 12 photographs showing large Brownhoist installations in various parts of the country, one photograph being provided for each month.

BULLETIN No. 4 of the Maine Electric Co., Portland, Maine, describes the method of handling coal at the Hell Gate Station of the United Electric Light & Power Co., of New York City. Complete details are given as to how a modern 150,000-kw. station handles its coal supply through the use of electrically driven coal handling equipment.

JONES "STANDARD" Under-Feed Stokers are discussed in the bulletin by the Under-Feed Stoker Co. of America which is a division of the Sanford Riley Stoker Co., of Worcester, Mass. The operation of the stoker is gone into as well as the method of automatically controlling fuel and air. There are also numerous illustrations of the application of this stoker to various types of boiler.

IN ORDER TO acquaint the industrial gear user with the advantages of Micarta gears, the Westinghouse Electric & Manufacturing Co. has issued a 20-page booklet, Folder 4506, entitled "Salient Facts on Silent Gears." The booklet describes the advantages of the use of Micarta gears and pinions and gives photographs and data describing some of their applications, tables of gear data, etc., enabling the gear user to judge whether or not they are applicable to his machinery.

INTERNATIONAL Combustion Engineering Corporation, of New York City, has issued a bulletin which covers briefly the apparatus built by its various subsidiary organizations. The list of these organizations is given and some details of the engineering personnel are also presented. The Frederick stoker, Lopulco pulverized fuel systems, Coxe traveling grate stoker, Type E stoker, Quinn fuel oil burner, Lopulco coal dryer, Type K. stoker, Green chain grate stoker and the Green steam jet ash conveyor and cast-iron hopper are some of the items which are described.

IMPORTANCE OF REMOVING scale from boiler and condenser tubes, methods to follow and types of equipment to use are discussed in the new 32-page catalog of the Roto Co., of Hartford, Conn. The cause of boiler scale and its effect on the boiler are points that are fully covered. It is shown that the removal of scale has an actual dollars and cents value which will soon pay for the cleaning equipment and figures are given to substantiate the point. All of the various types of air, steam and water driven Roto tube cleaners are illustrated and the action explained.

"BRASS PIPE AND PIPING" makes up the subject of Bulletin 15 now being issued by the Bridgeport Brass Co., of Bridgeport, Conn. This book contains information on all the subjects that need to be considered by an architect or an engineer when deciding the question of water supply pipe material. The effect of corrosion on iron and steel pipe is discussed, together with some of the means which have been used to overcome this difficulty, such as deactivation and deaeration. The bulletin then goes on to show how brass pipe may be used because of its non-corrosive properties, and some of the methods of handling brass piping installations are described.

DE LAVAL STEAM TURBINE Co., of Trenton, N. J., has issued folders describing the power equipment of the Crown Willamette Paper Company at West Linn, Ore., and equipment of the Marquette Cement and Manufacturing Co., of La Salle, Ill. The installation in the paper mill is of particular interest because of the sectionalized speed control of the paper machine. In the plant of the cement company, the current is supplied by a direct current generator of 3750 kw. capacity and driven by a De Laval compound gear turbine. The turbine has two shafts, the pinions of which drive the gear coupled to the generator shaft. This arrangement is said to make it possible to combine a large number of turbine stages as required for high efficiency with the advantages of short rigid shaft.